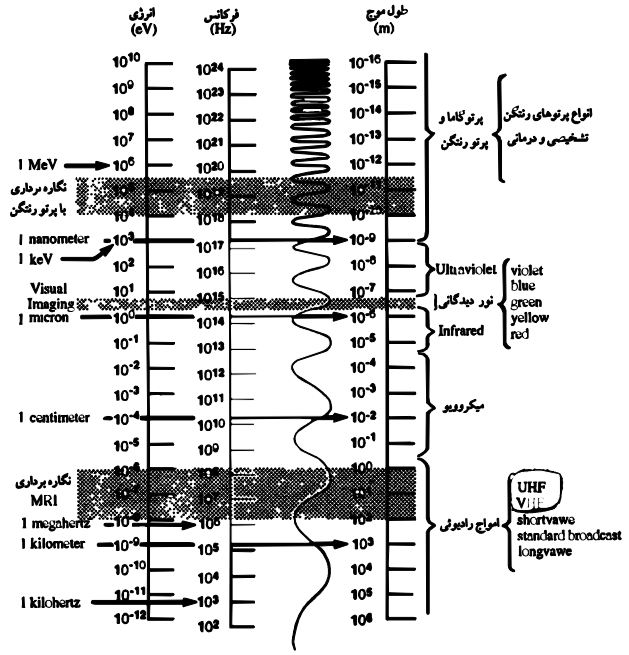
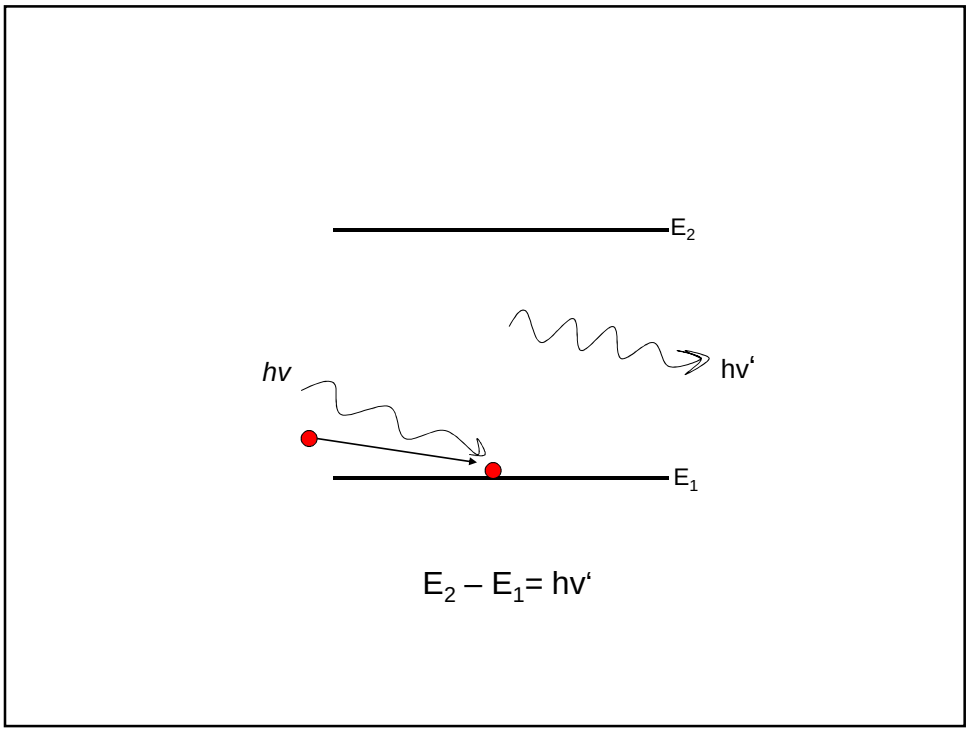
Medical physics

By: N. Gheibi

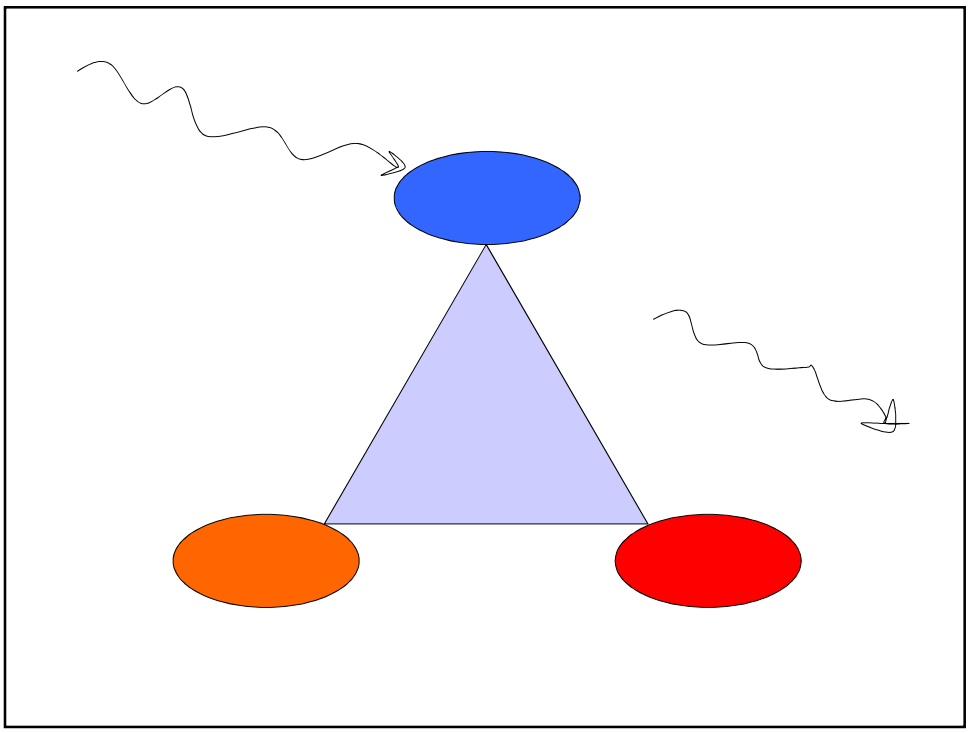
Ph.D of Biophysics

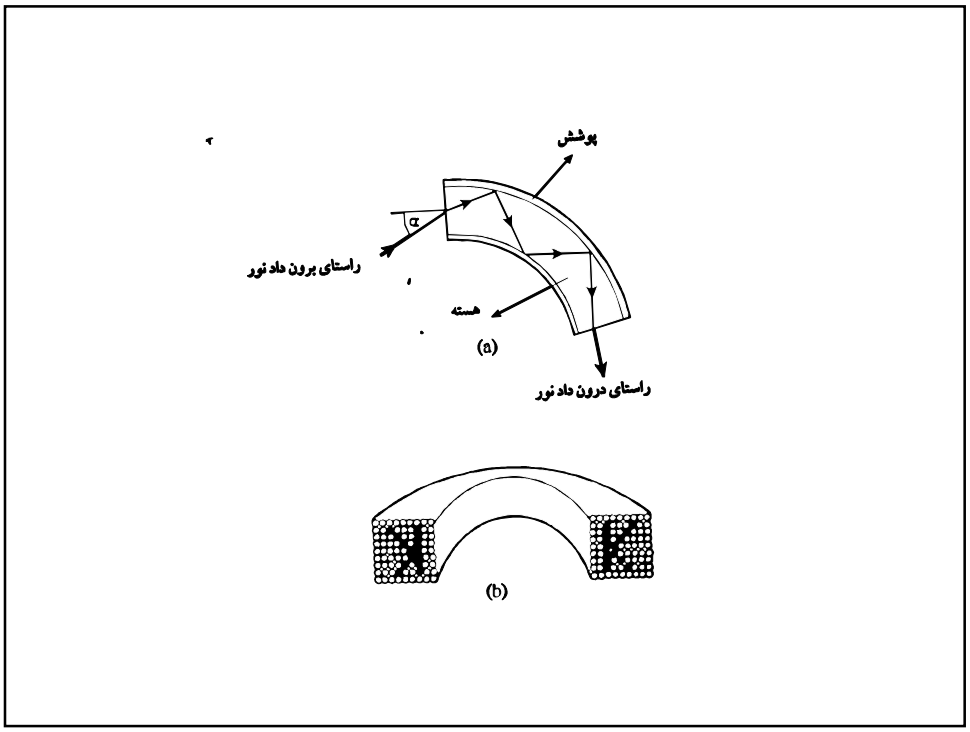
Qazvin University of Medical Sciences

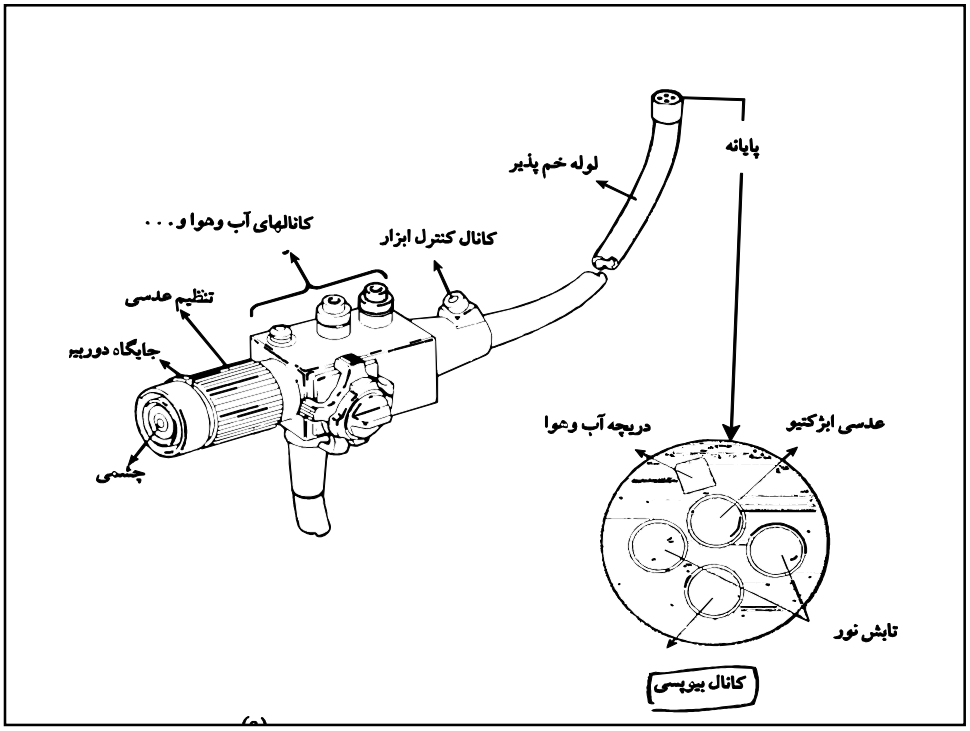


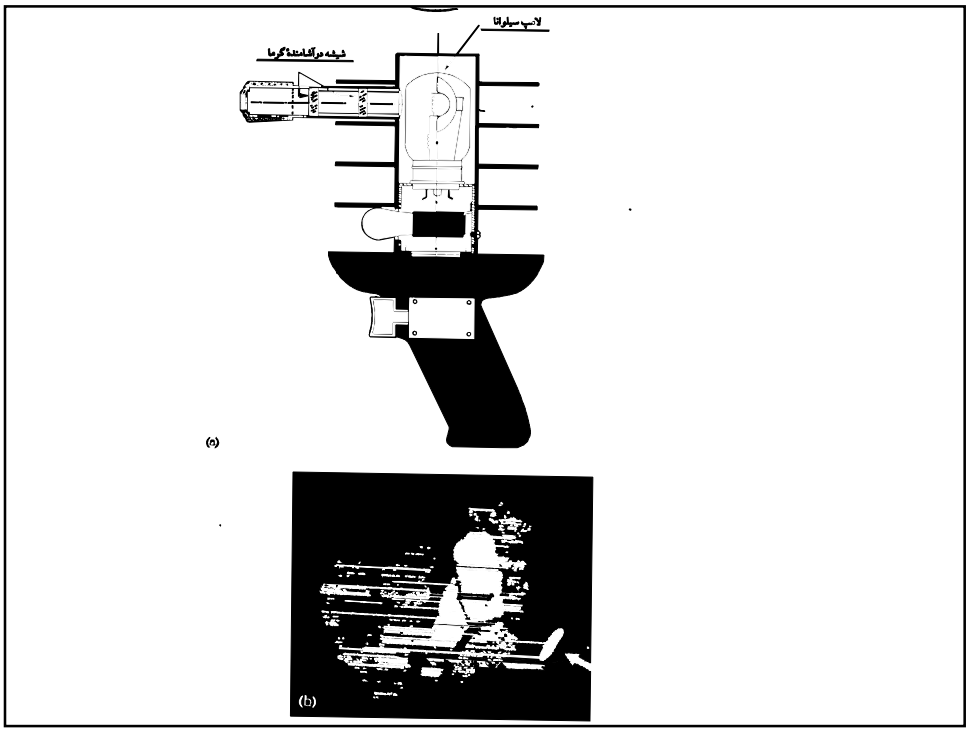


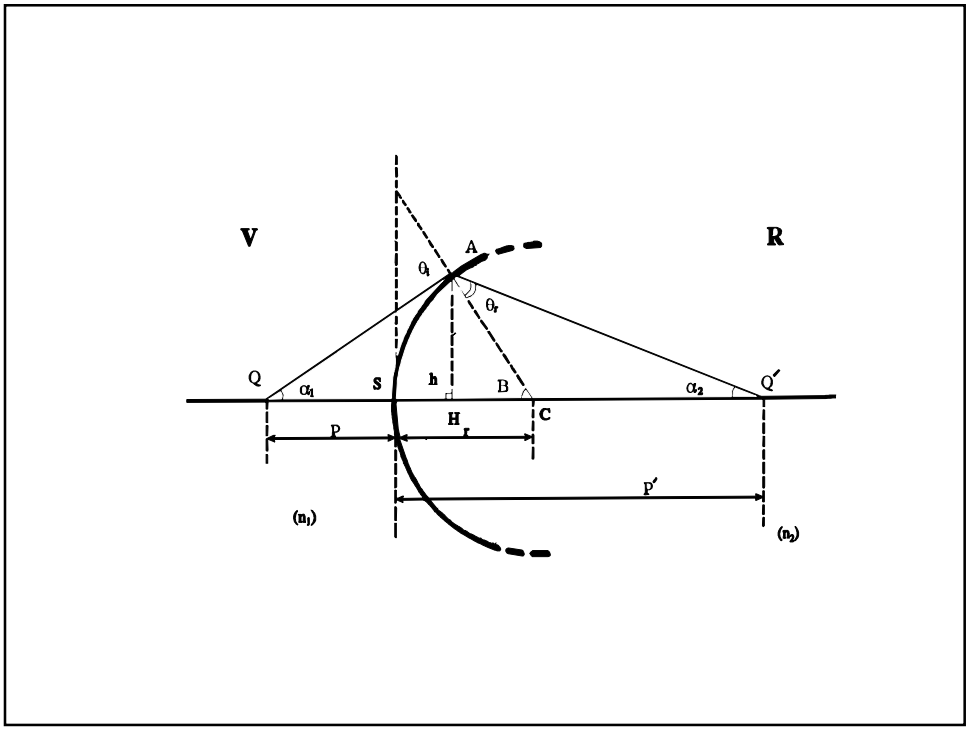
$E_2 - E_1 = hv'$

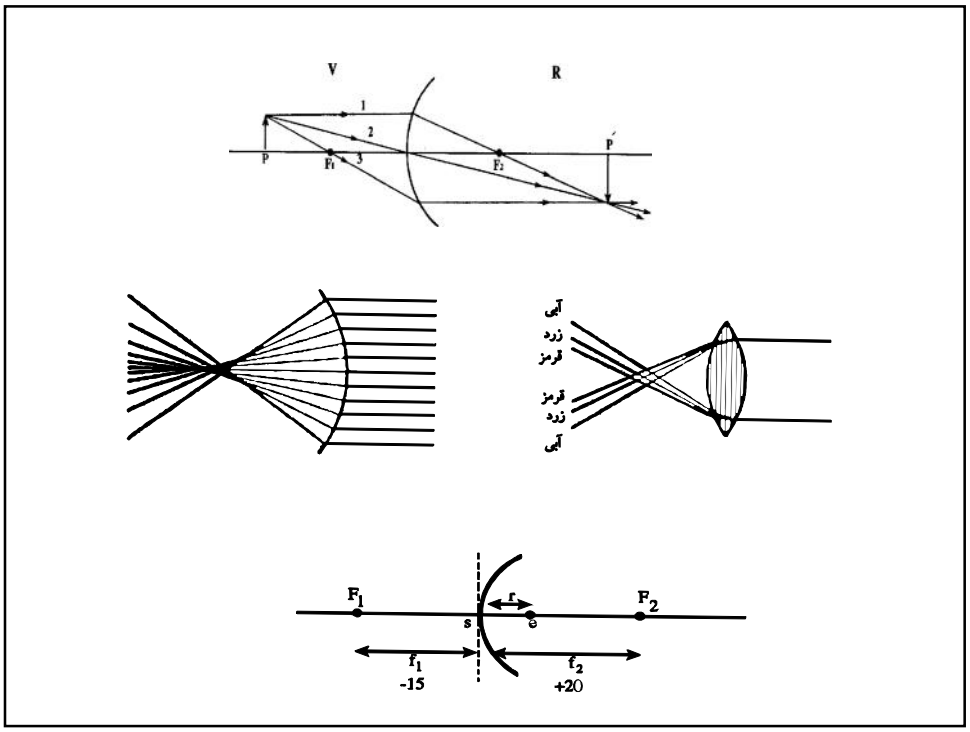


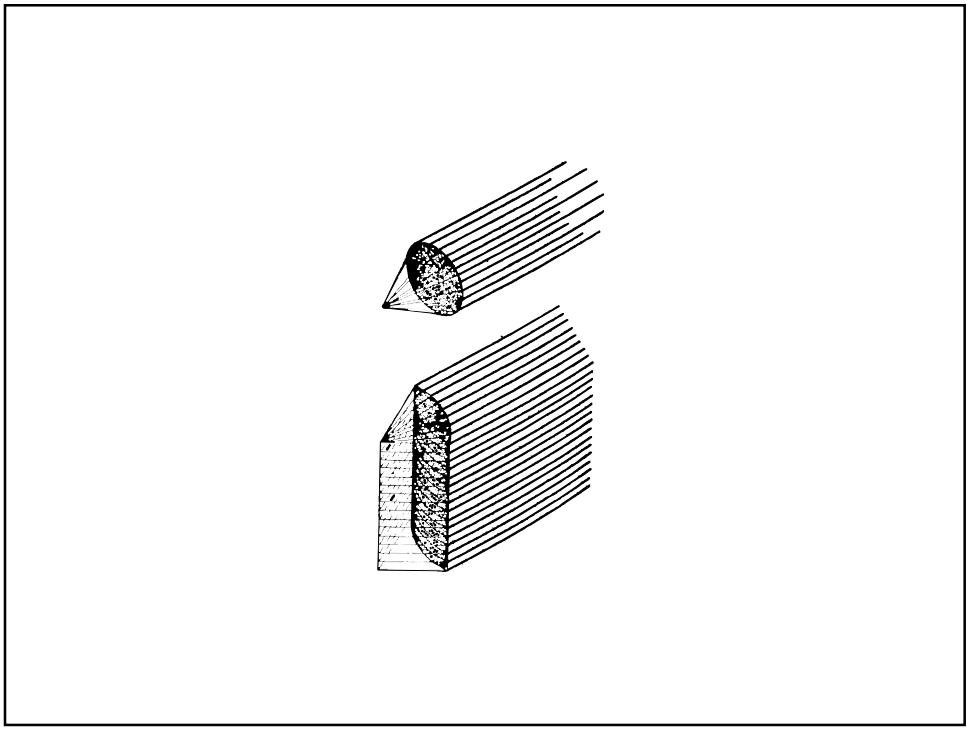

پوشش
α
راستای برون داد نور
هسته
(a)
راستای درون داد نور
A
B
(b)

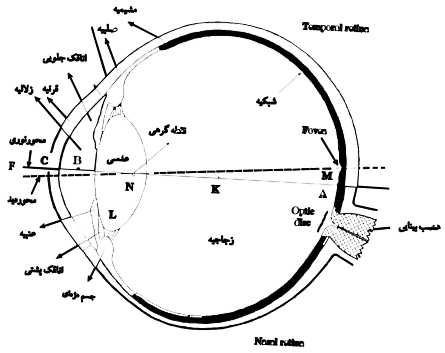

پایانه
لوله خم پذیر
کانالهای آب وهوا و . . .
کانال کنترل ابزار
تنظیم عدسی
جایگاه دوربین
چشمی
دریچه آب وهوا
عدسی ابژکتیو
تابش نور
کانال بیوپسی


(a)
(b)

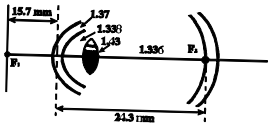

V
R
A
θ_i
θ_r
Q
α_1
S
h
B
α_2
Q′
C
H
r
p
p′
(n_1)
(n_2)

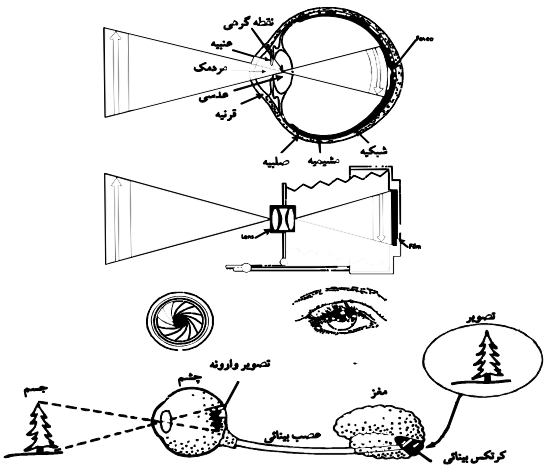

V
R
1
2
3
P
P'
F1
F2
آبی
زرد
قرمز
قرمز
زرد
آبی
F1
F2
f
s
e
f1
-15
f2
+20

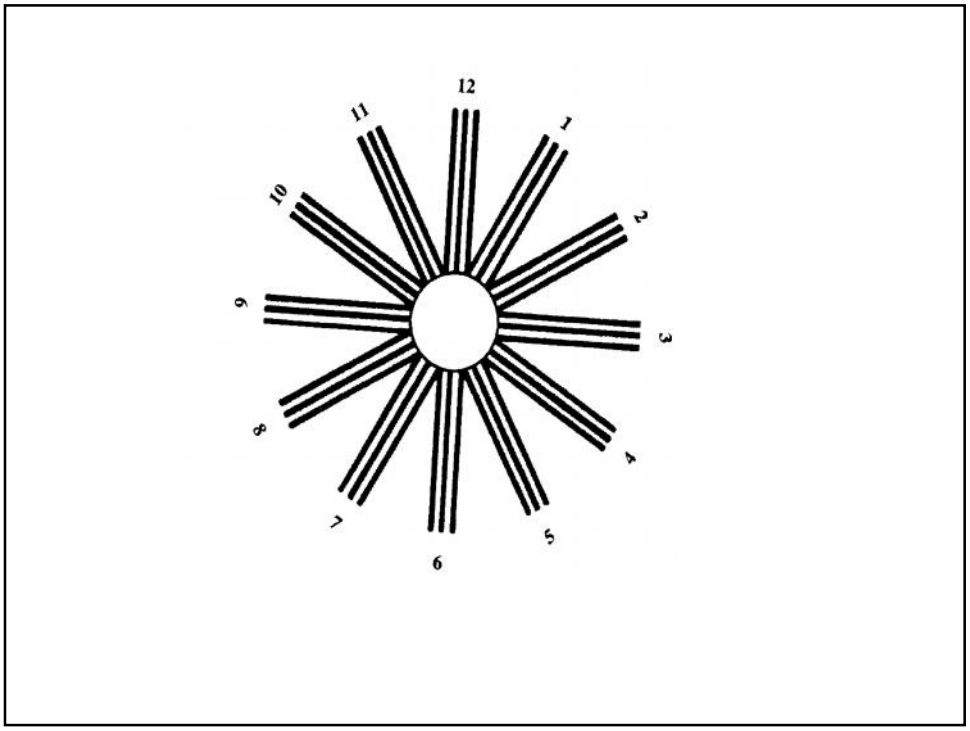


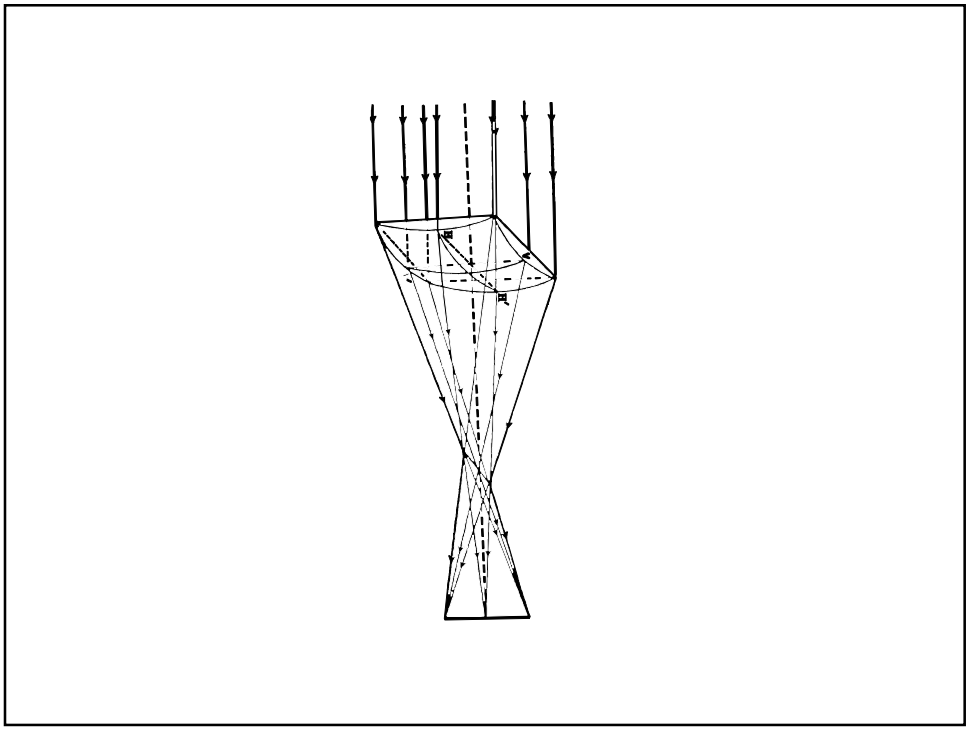


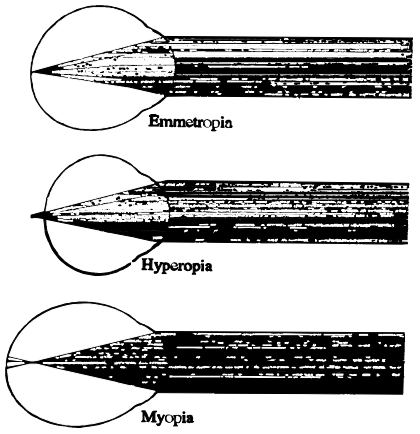
شکل (۴۲-۱) تصویر ساده شده چشم

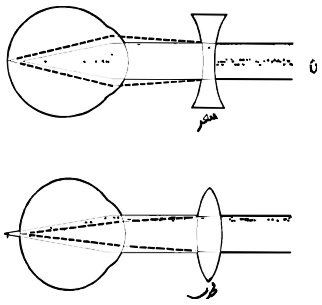


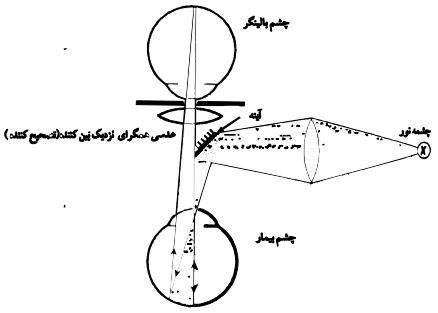



12
1
2
3
4
5
6
7
8
9
10
11

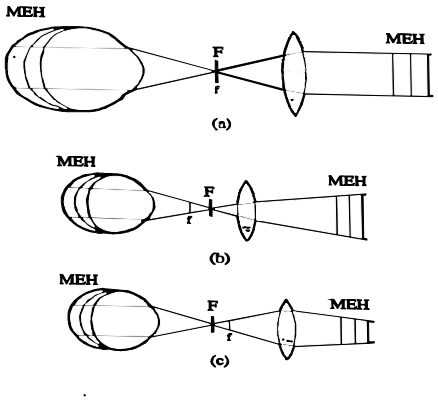




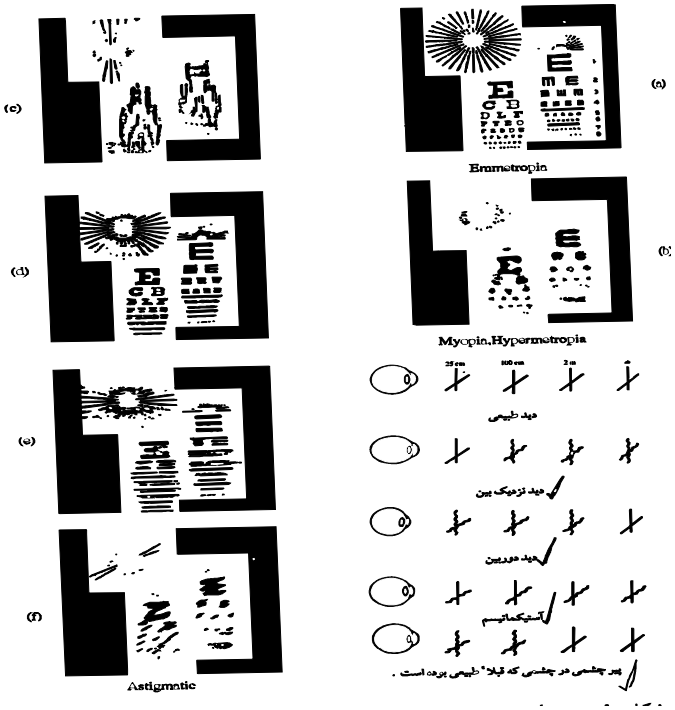


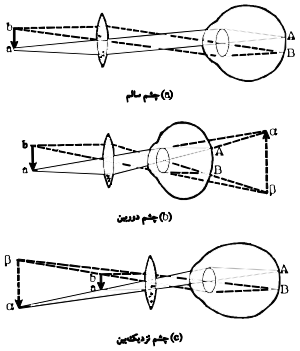


شکل (۶۰-۱) یک سیستم آفتالمزسکپی در آفتالمزسکپی نامستقیم

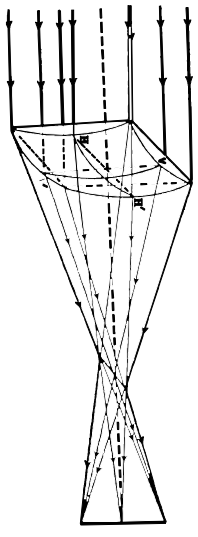

MEH
F
f
MEH
(a)
MEH
F
f
MEH
(b)
MEH
F
f
MEH
(c)

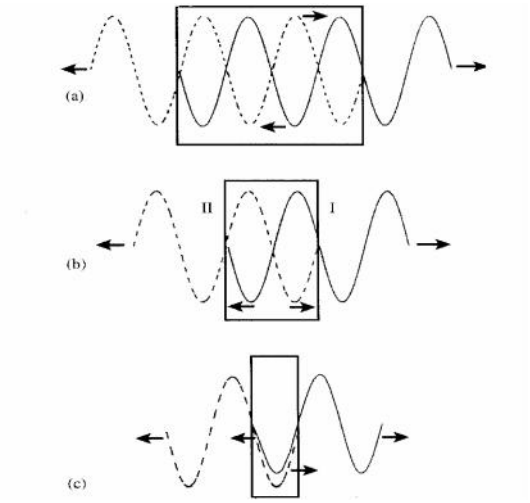
شکل (۶۲-۱)


(a)
Emmetropia
(b)
Myopia,Hypermetropia
(c)
(d)
(e)
(f)
Astigmatic
بعد طبیعی
بعد نزدیک بین
بعد دوربین
آستیگماتیسم
بعد چشمی در چشمی که قبلاً طبیعی بوده است .



شکل (۶۱-۱) چگونگی شکست نزر در آفتالدرسکپی نامستیم (a) چشم سالم (b) چشم دوربین (c) چشم نزدیکبین





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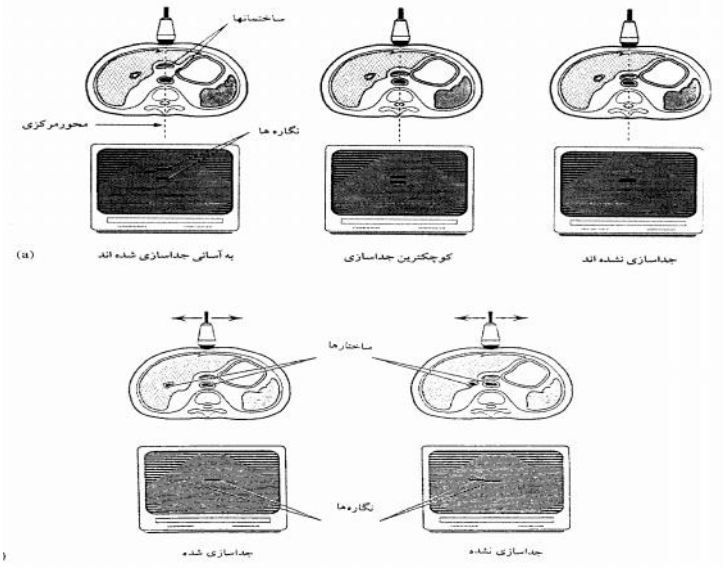

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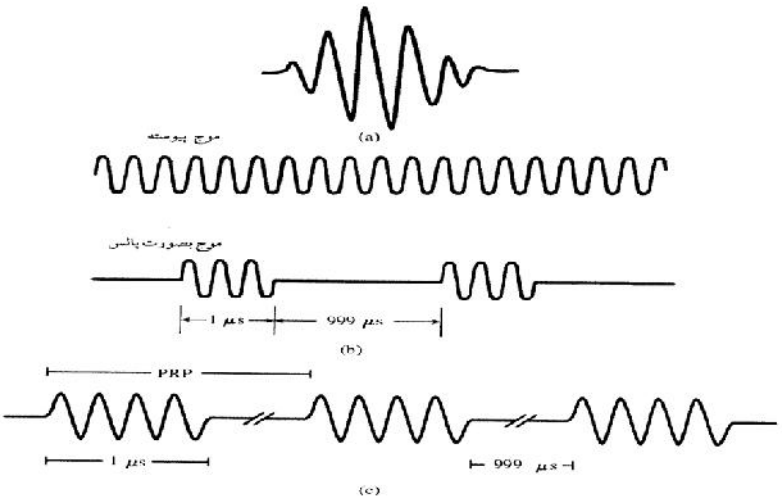

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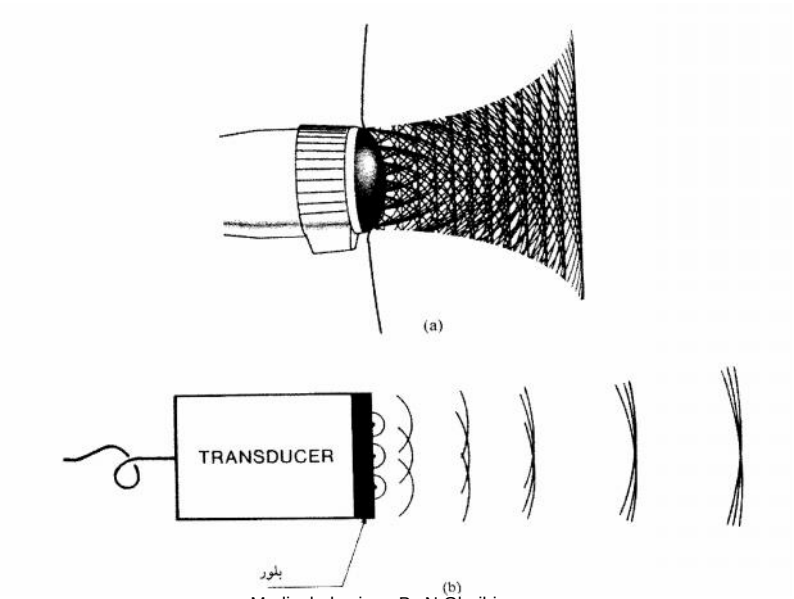

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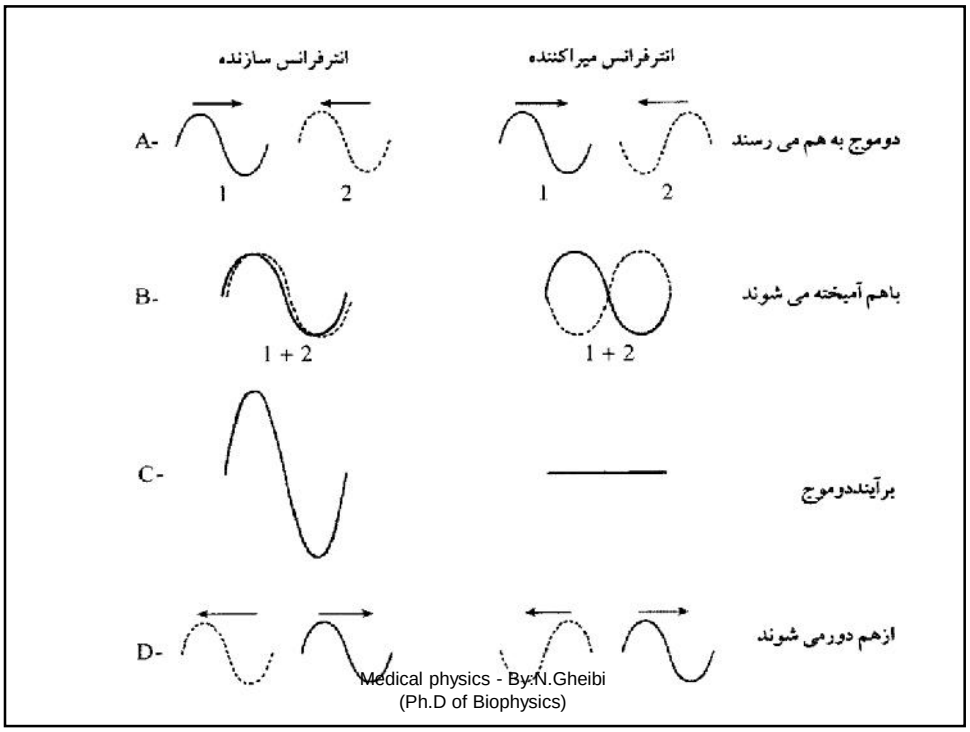

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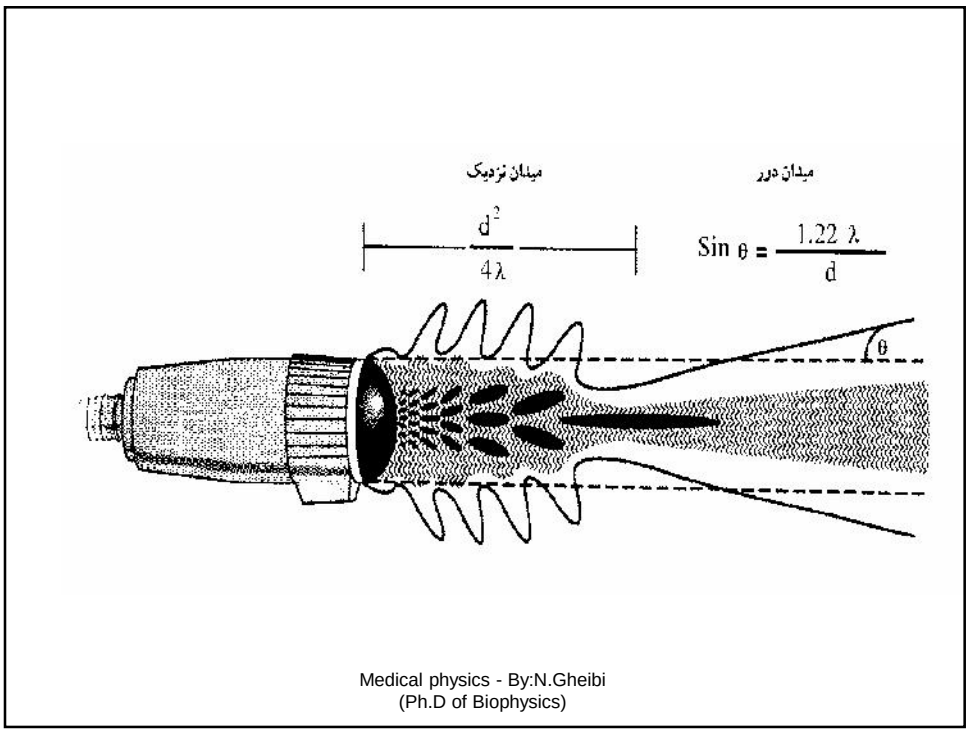

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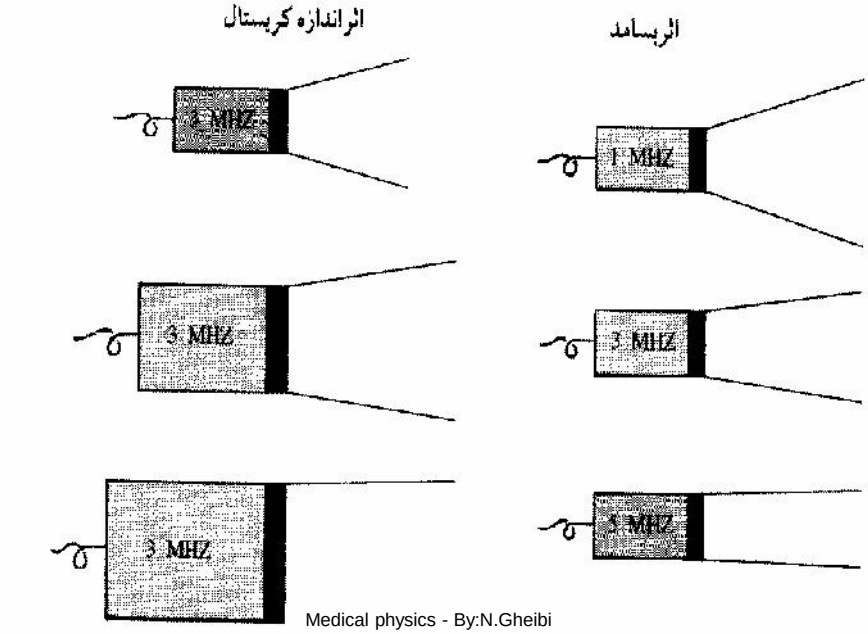

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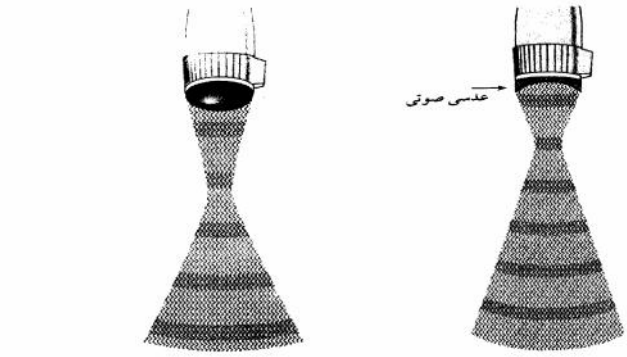
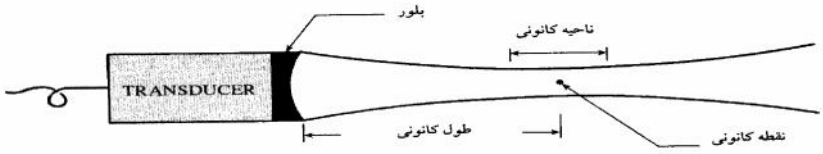


شکل (۲۱-۲) همگراکردن امواج فراصوت



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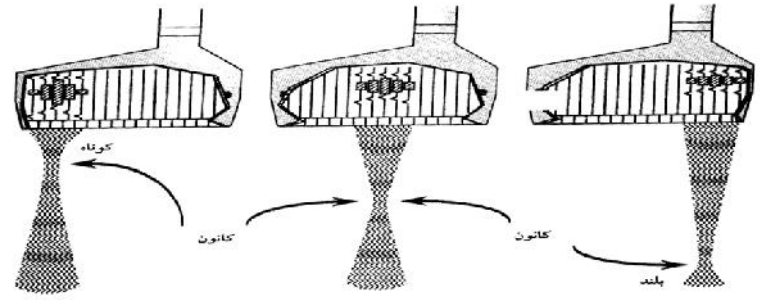
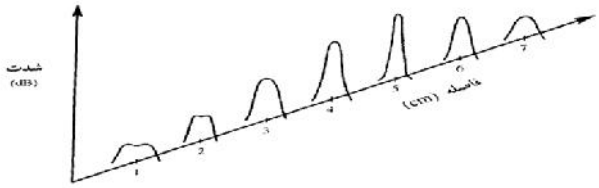


شکل (۲۳-۲) تأخیر در انگیزش بلورهای ترانسدیوسر باعث کانونی شدن دسته پرتو می‌شود.



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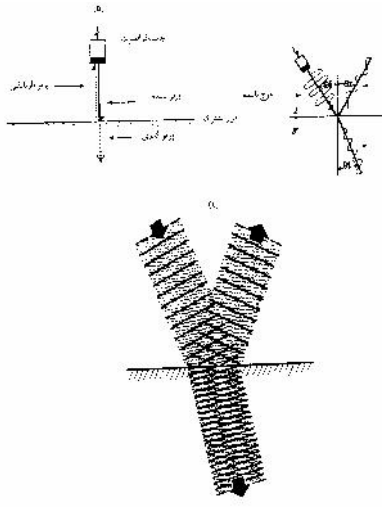

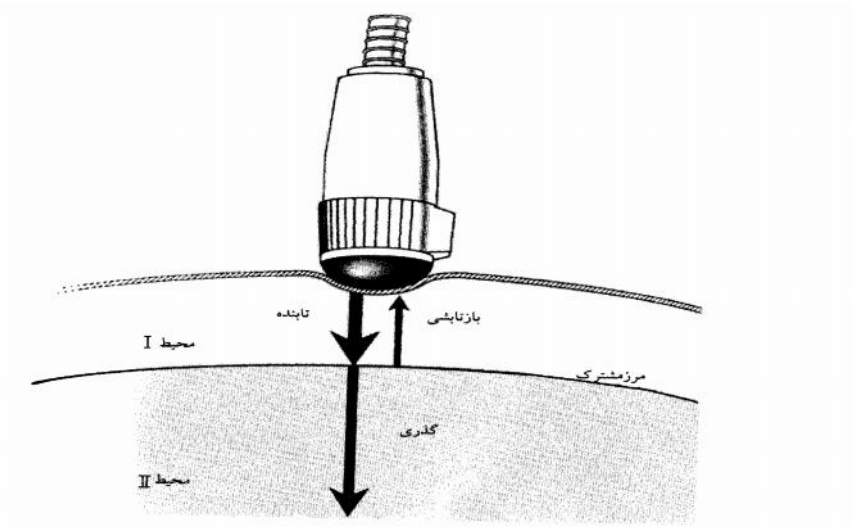

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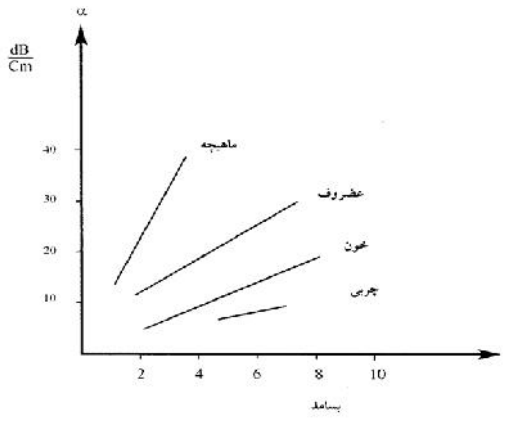

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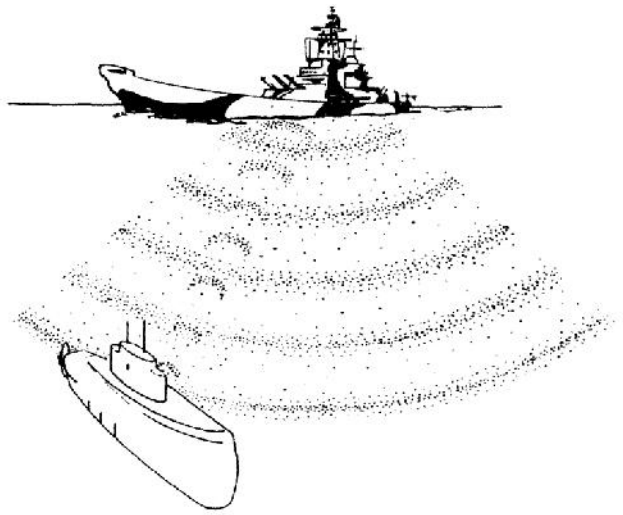

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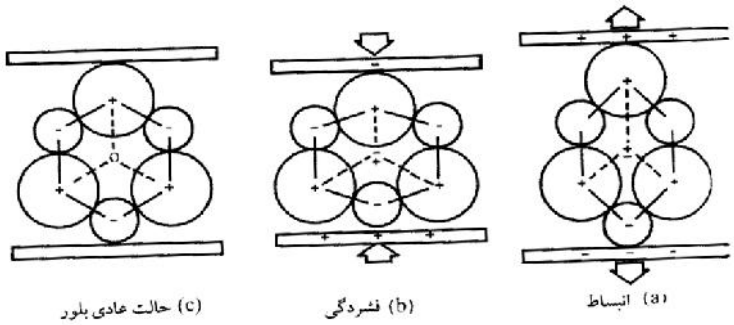

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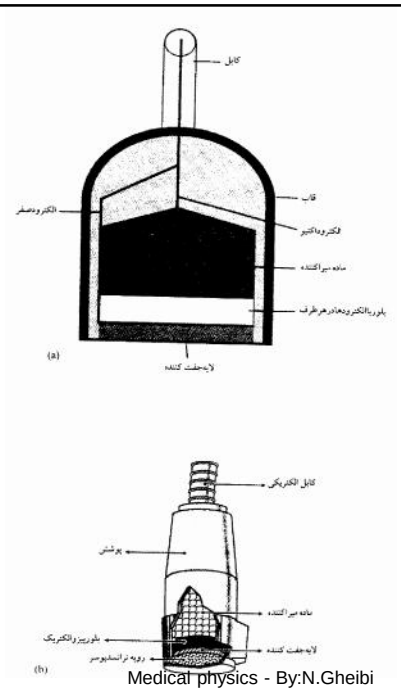

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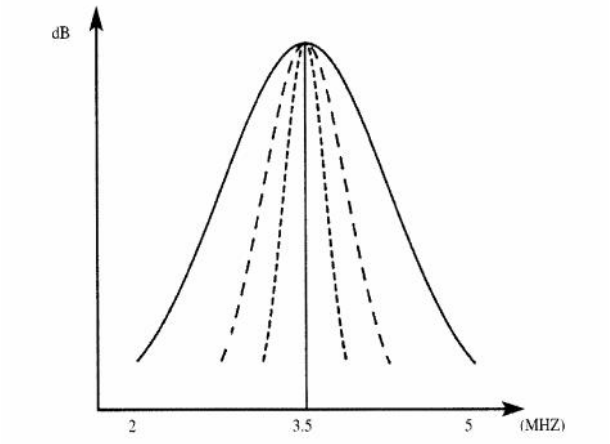

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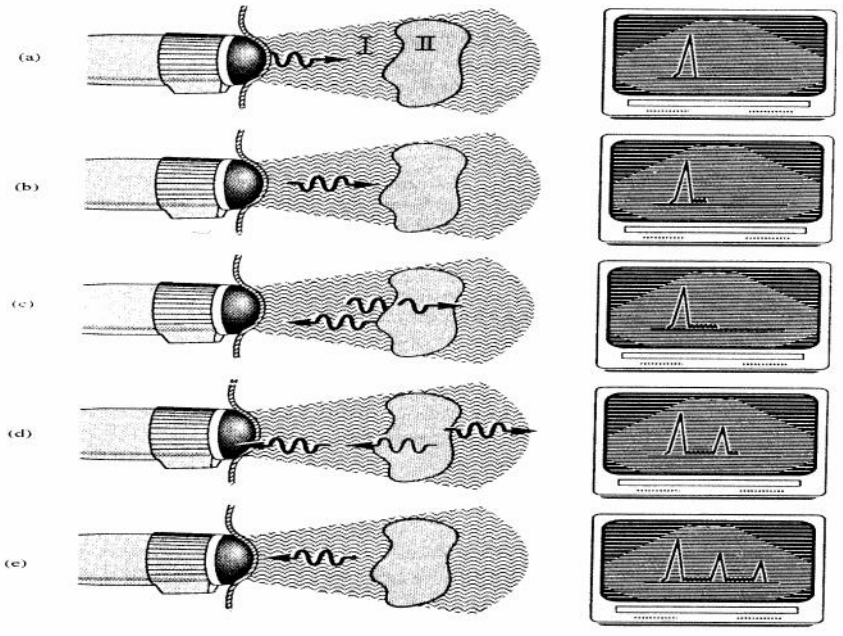

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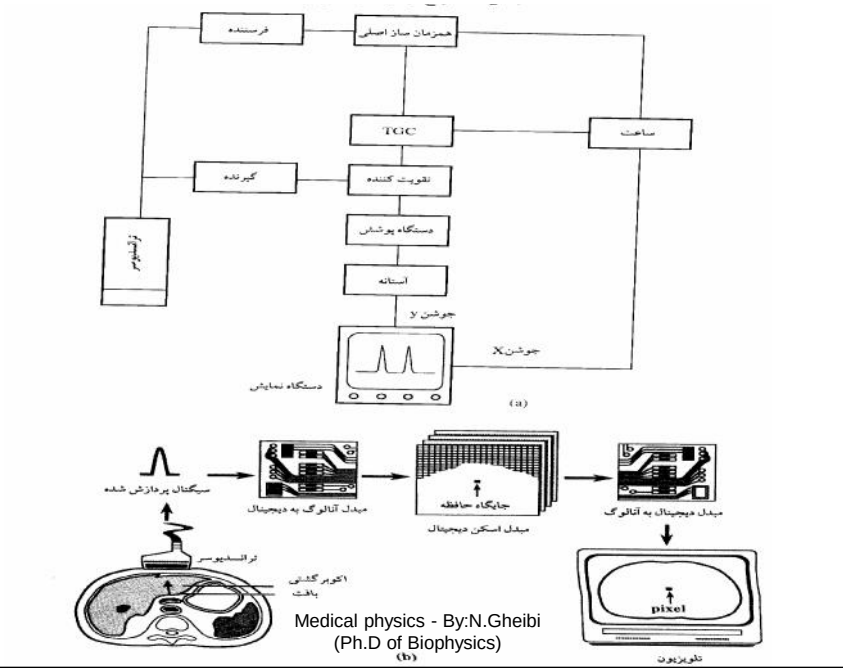

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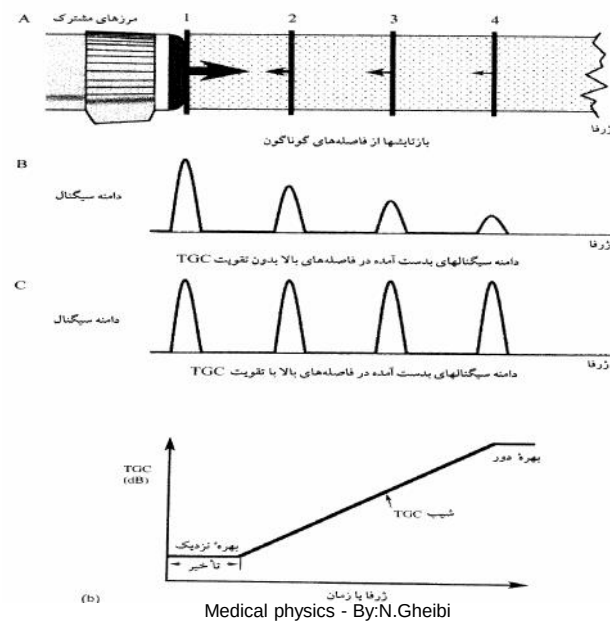

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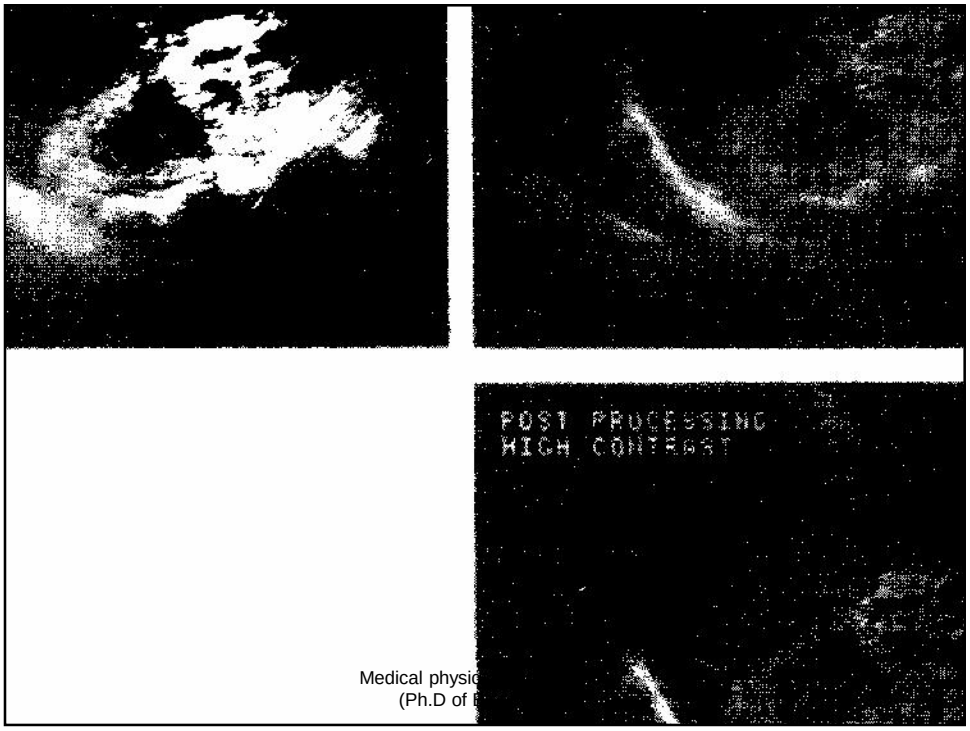

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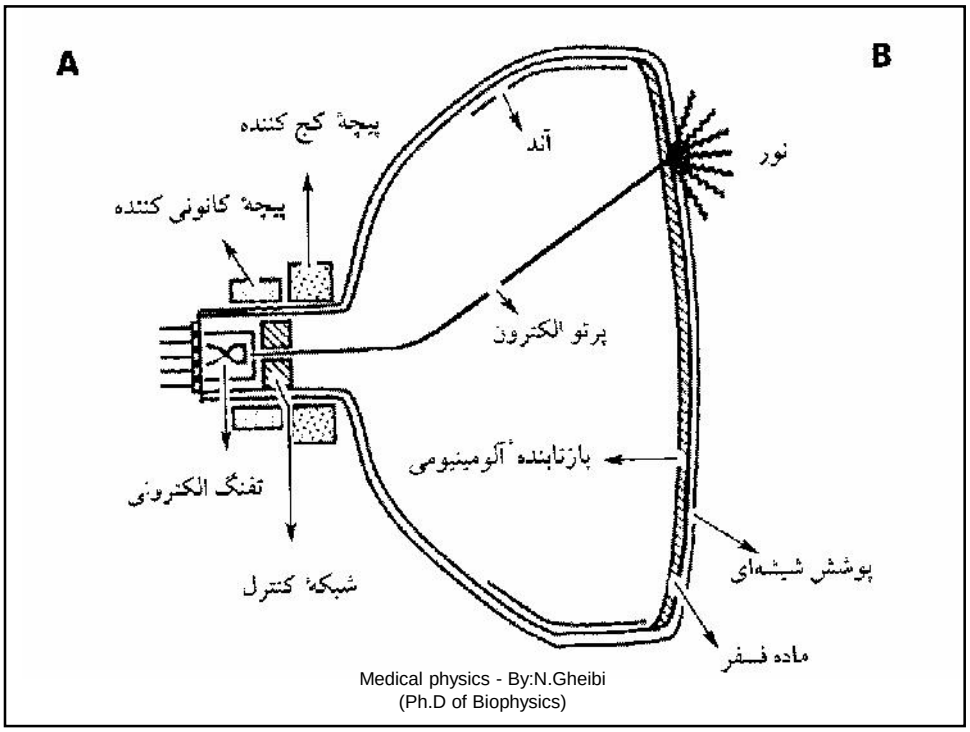
(Ph.D of



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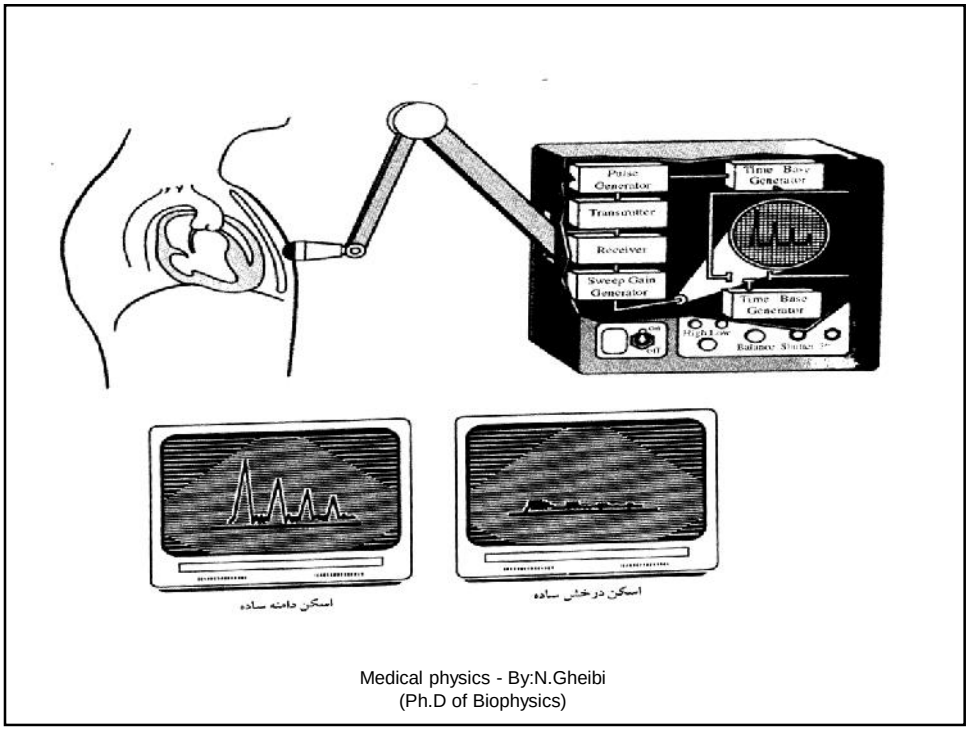

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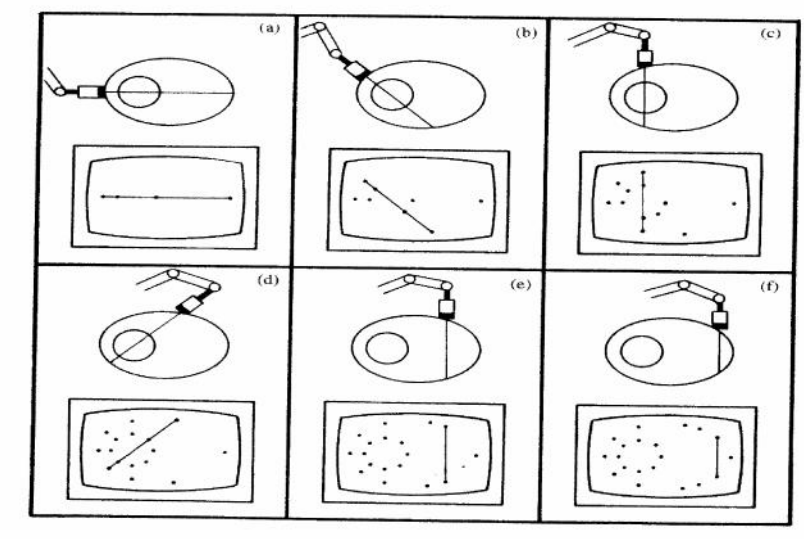
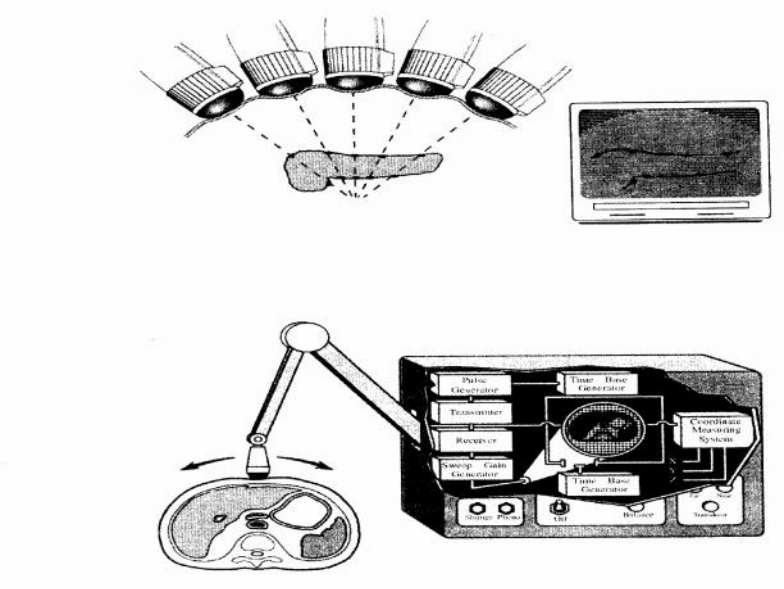
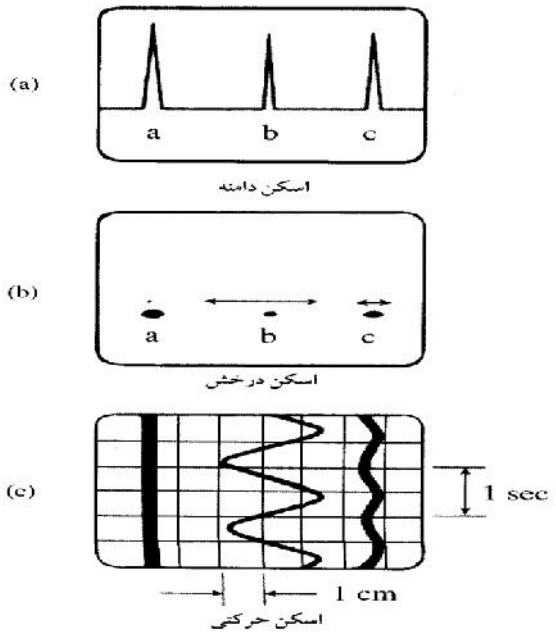
(Ph.D of Biophysics)



Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



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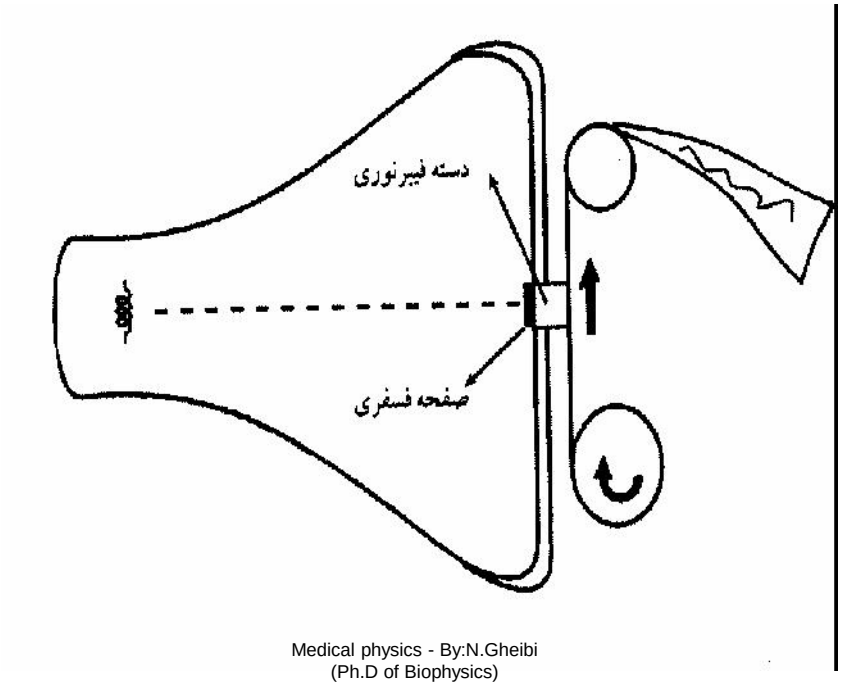

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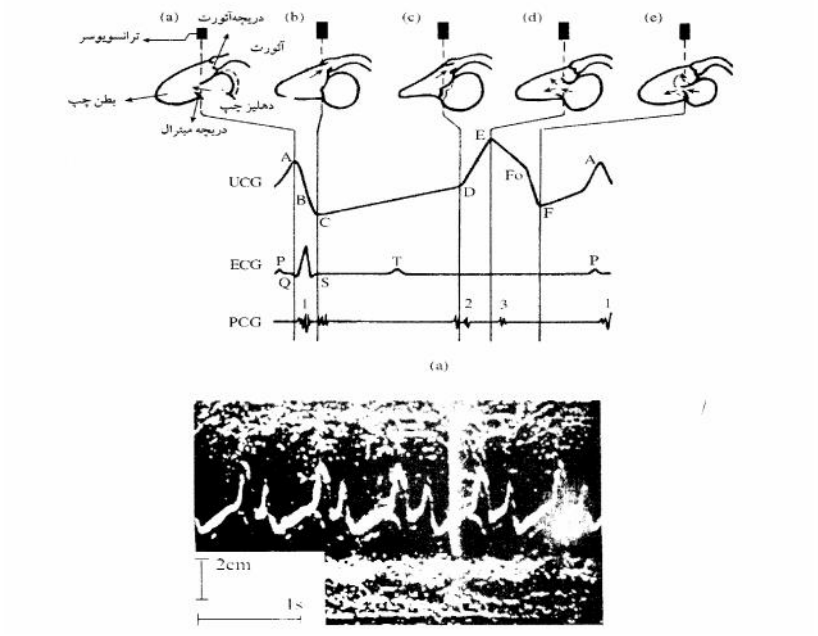

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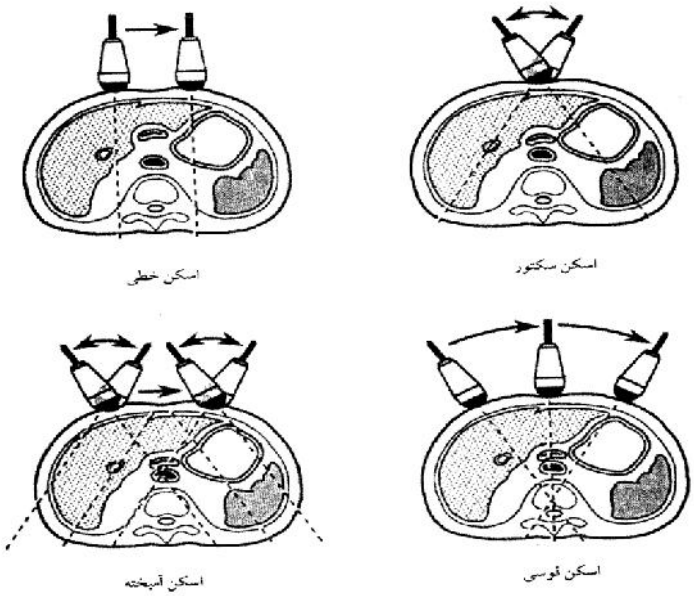

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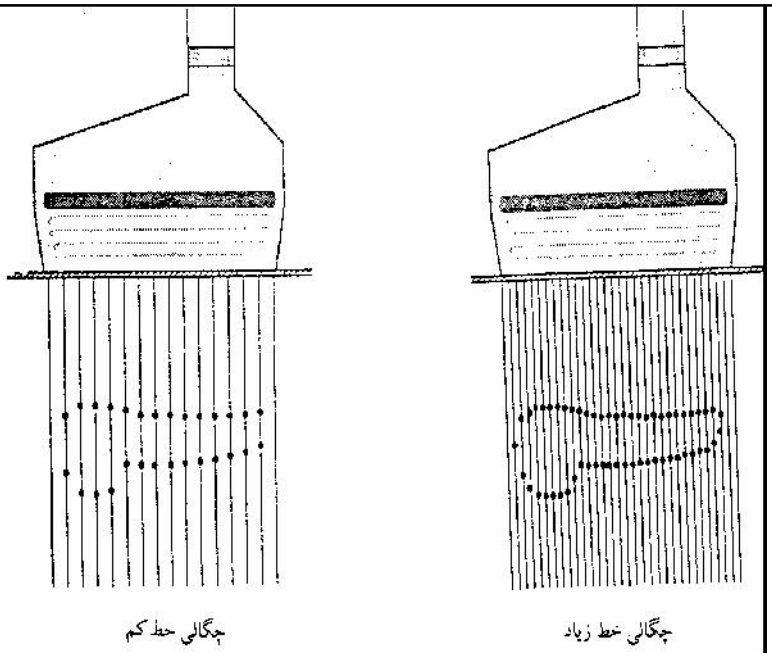

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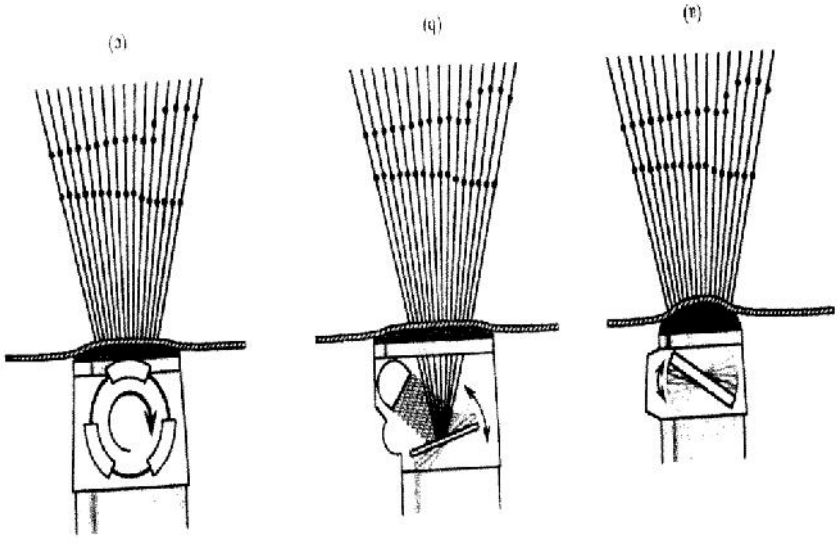

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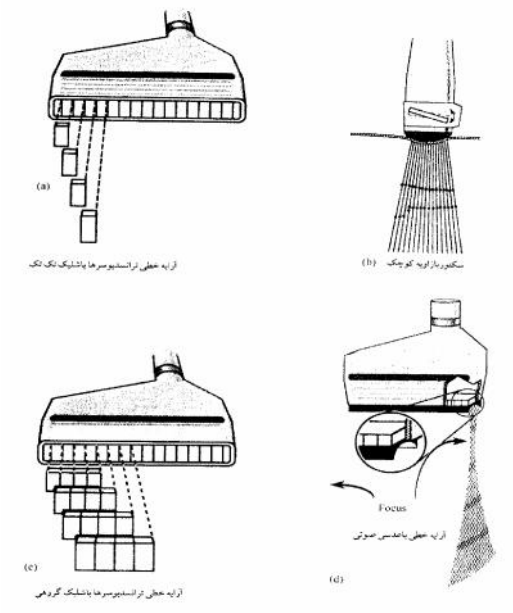

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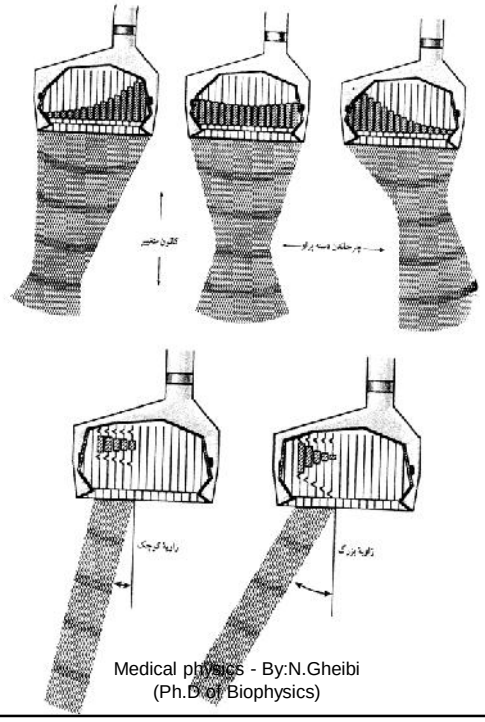

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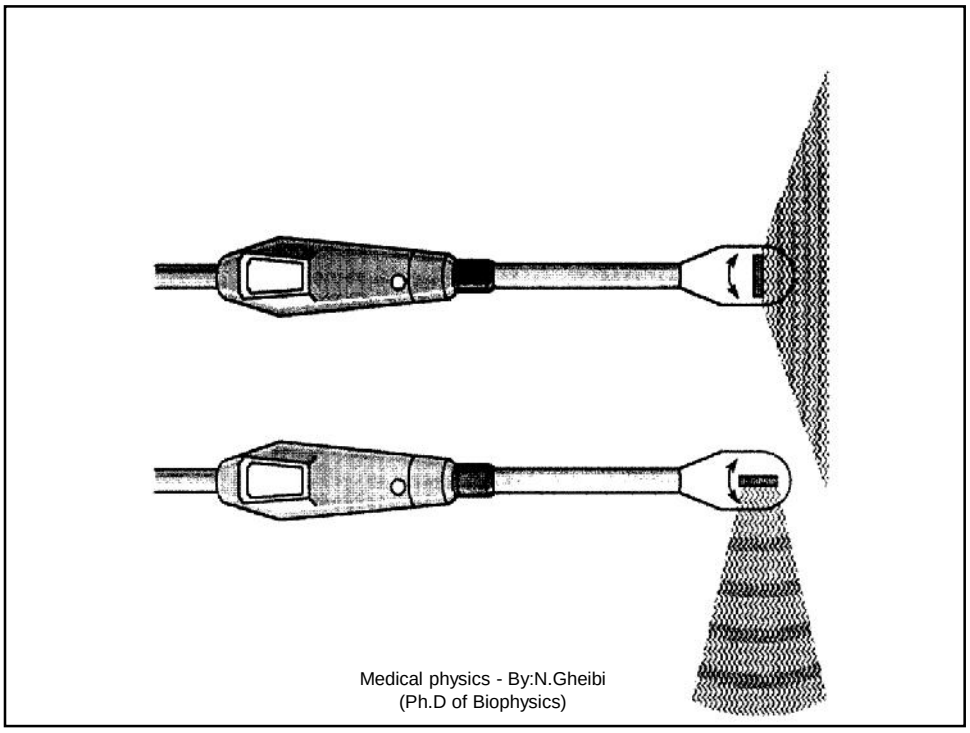

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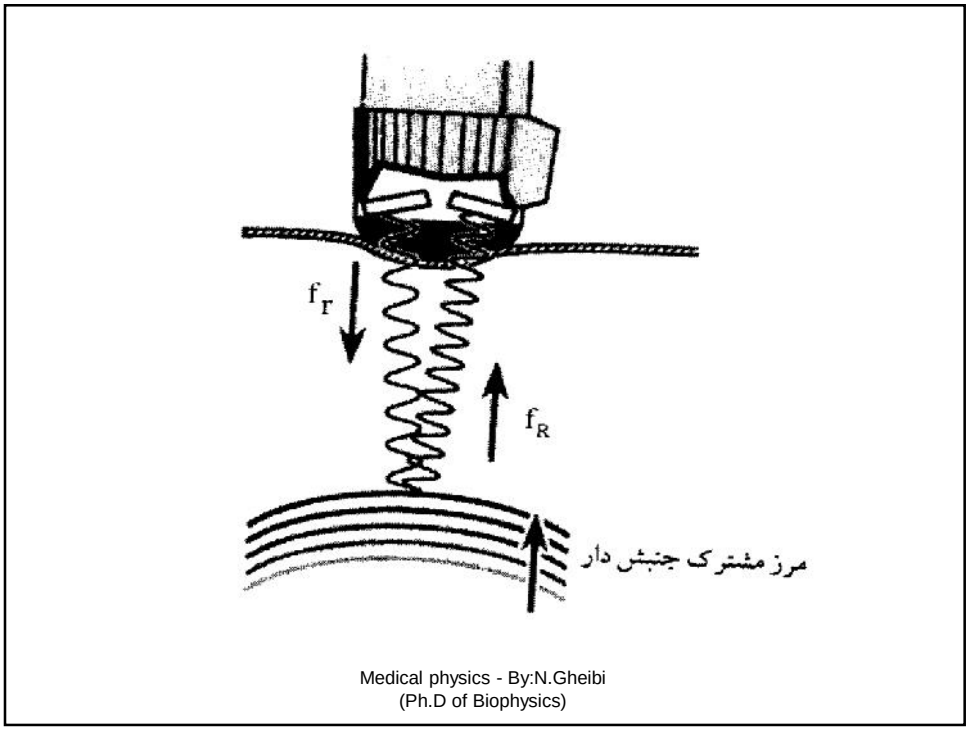

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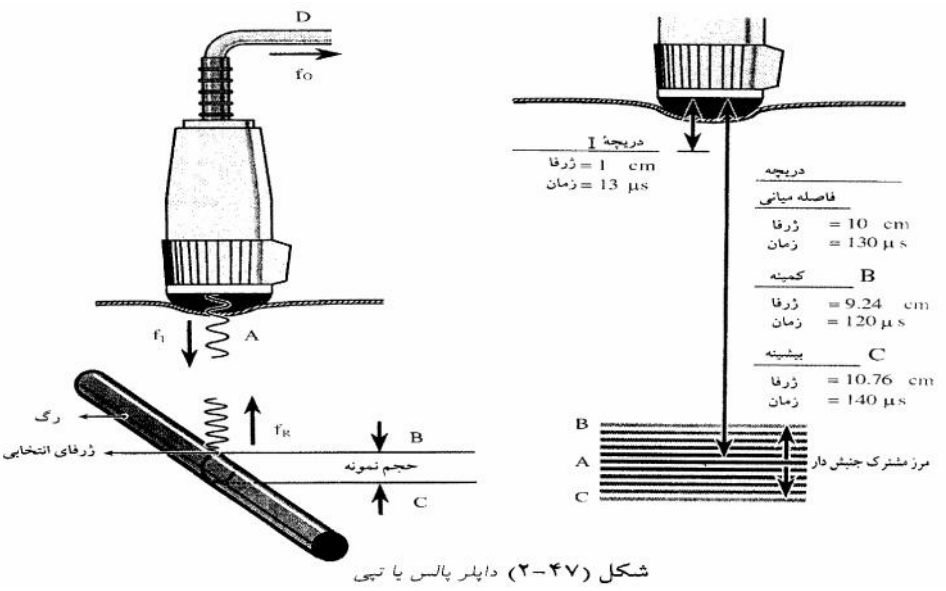
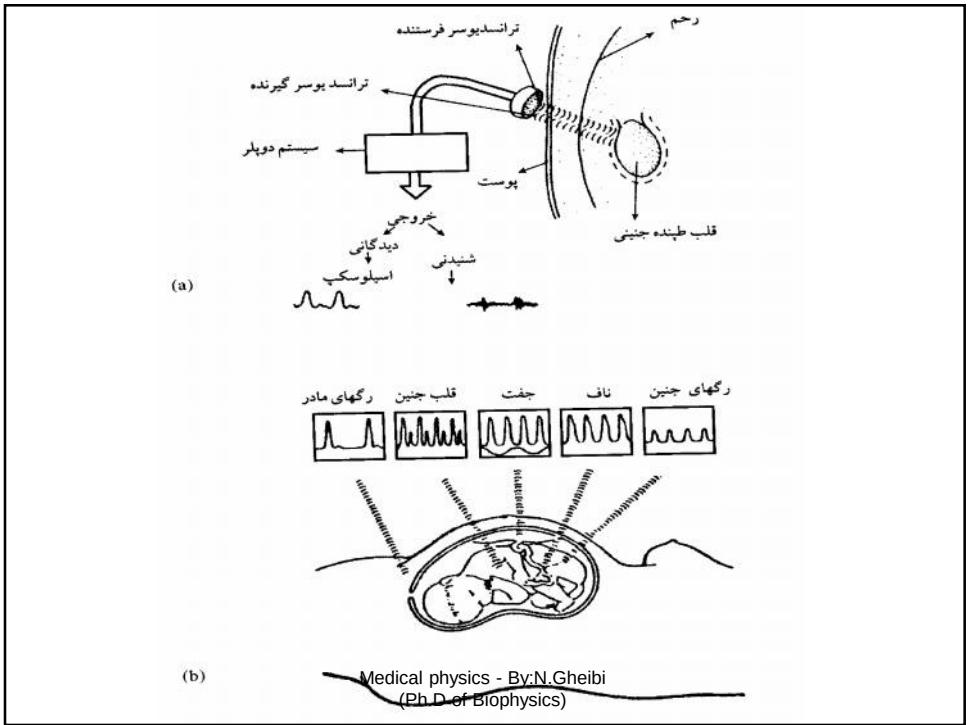
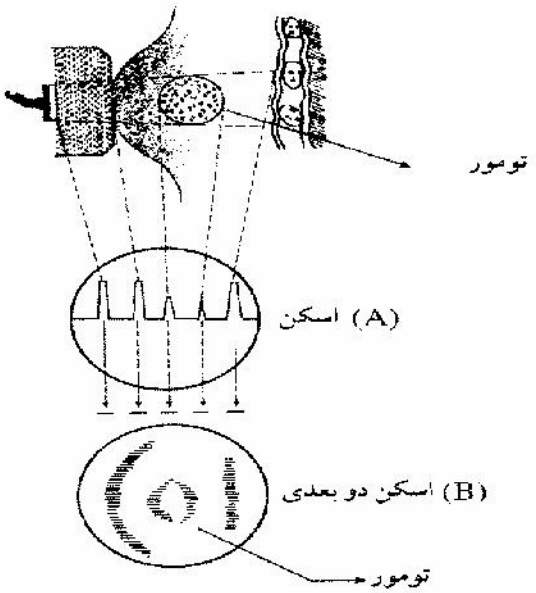


شکل (۴۷-۲) داپلر پالس یا تپی

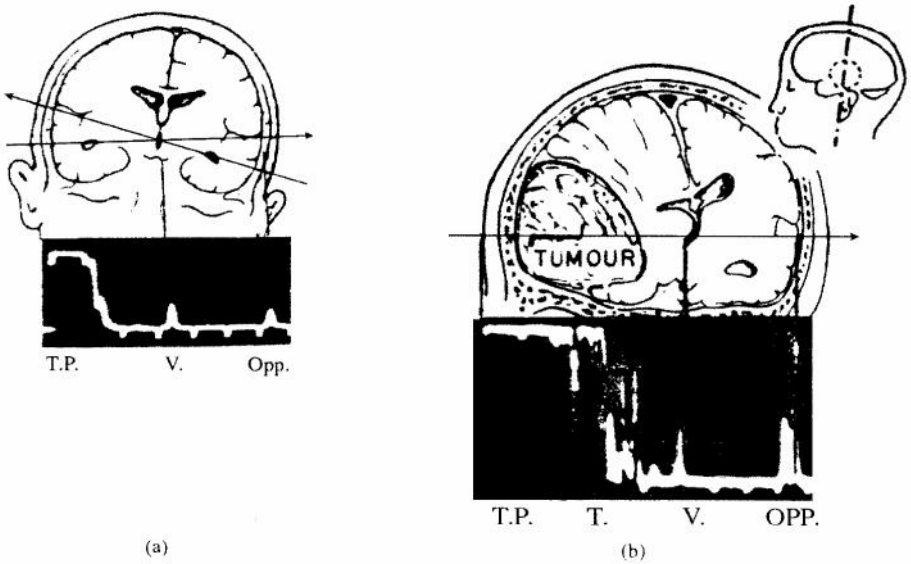
Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



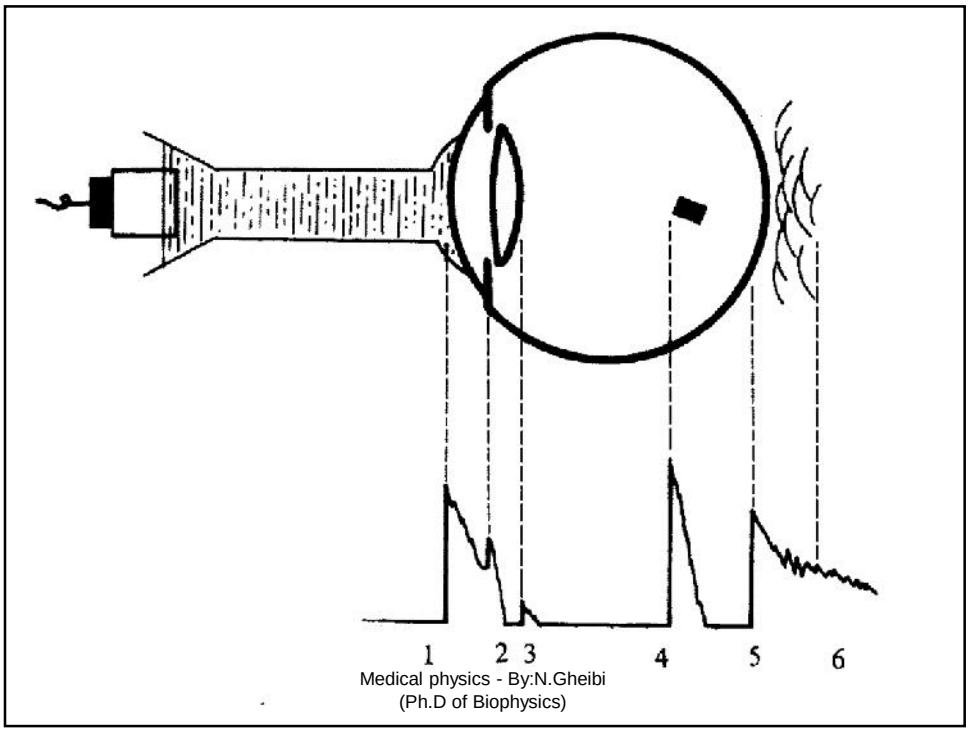
Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



Medical physics - By:N.Gheibi
(Ph.D of Biophysics)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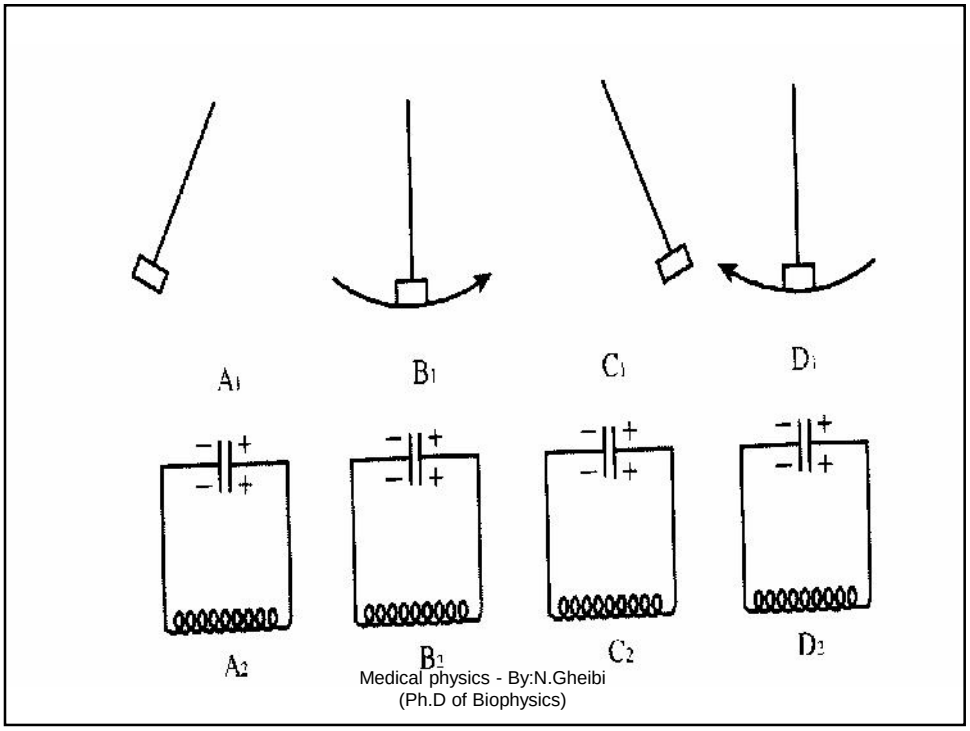
(Ph.D of Biophysics)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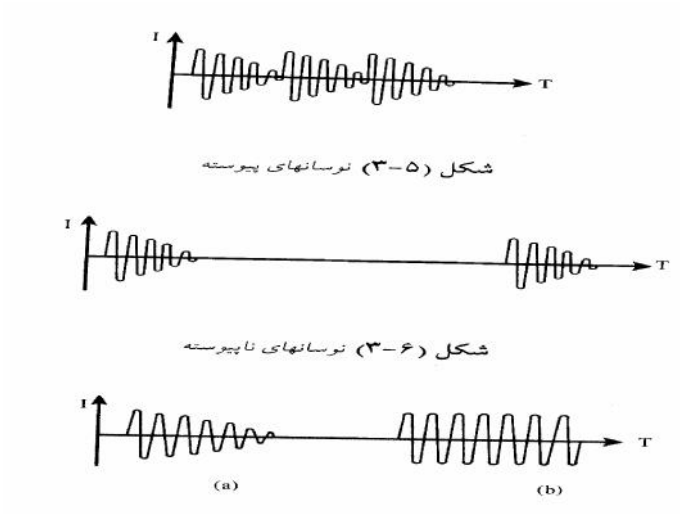
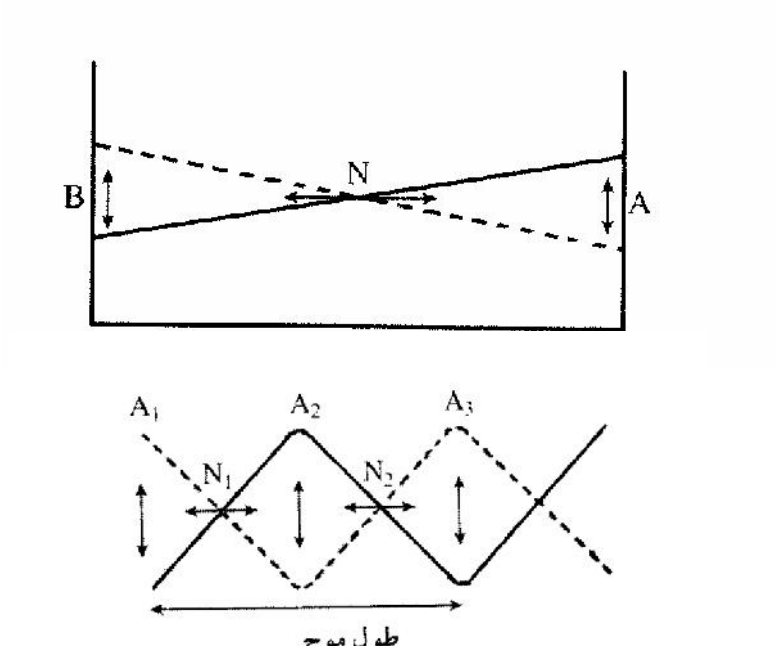
(Ph.D of Biophysics)



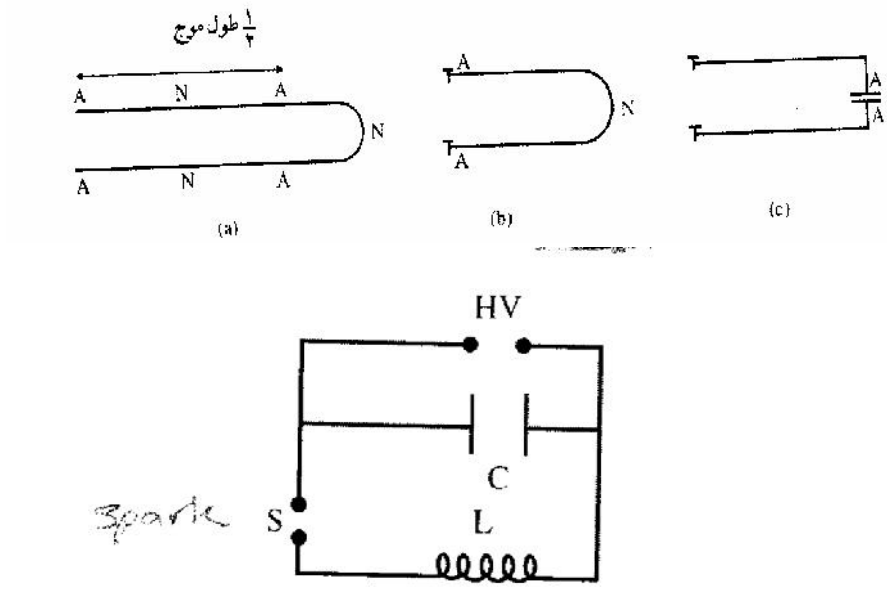
شکل (۵-۳) نوسانهای پیوسته

شکل (۶-۳) نوسانهای ناپیوسته

Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



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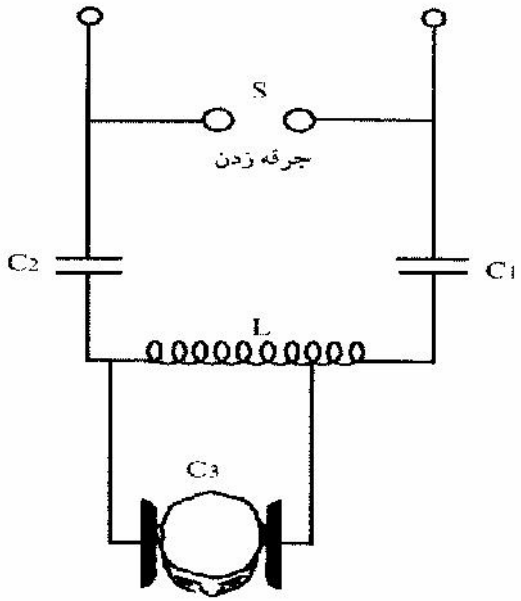
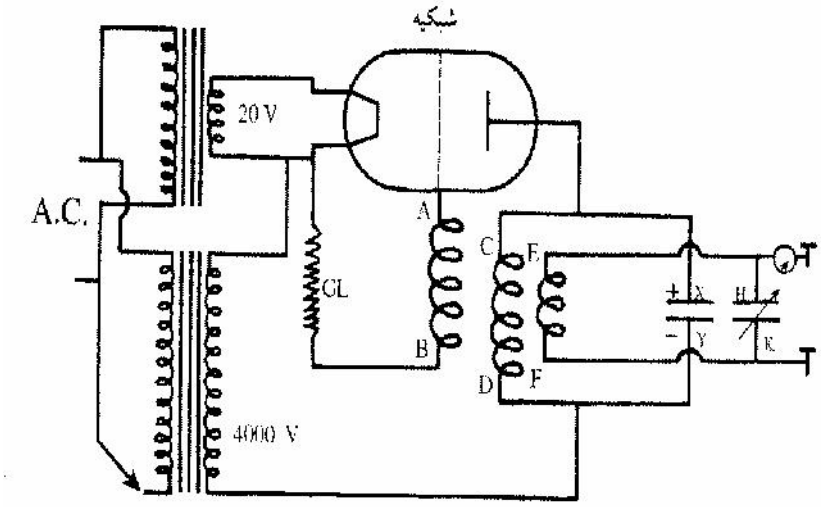
(Ph.D of Biophysics)



Medical physics - By:N.Gheibi
(Ph.D of Biophysics)



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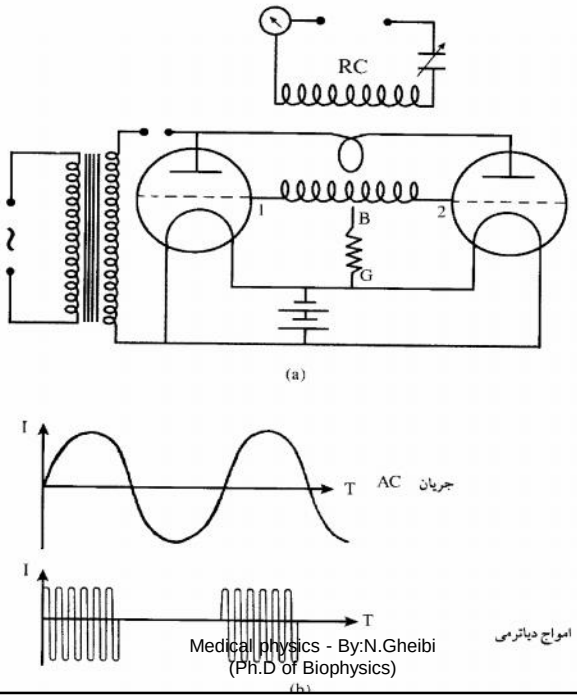

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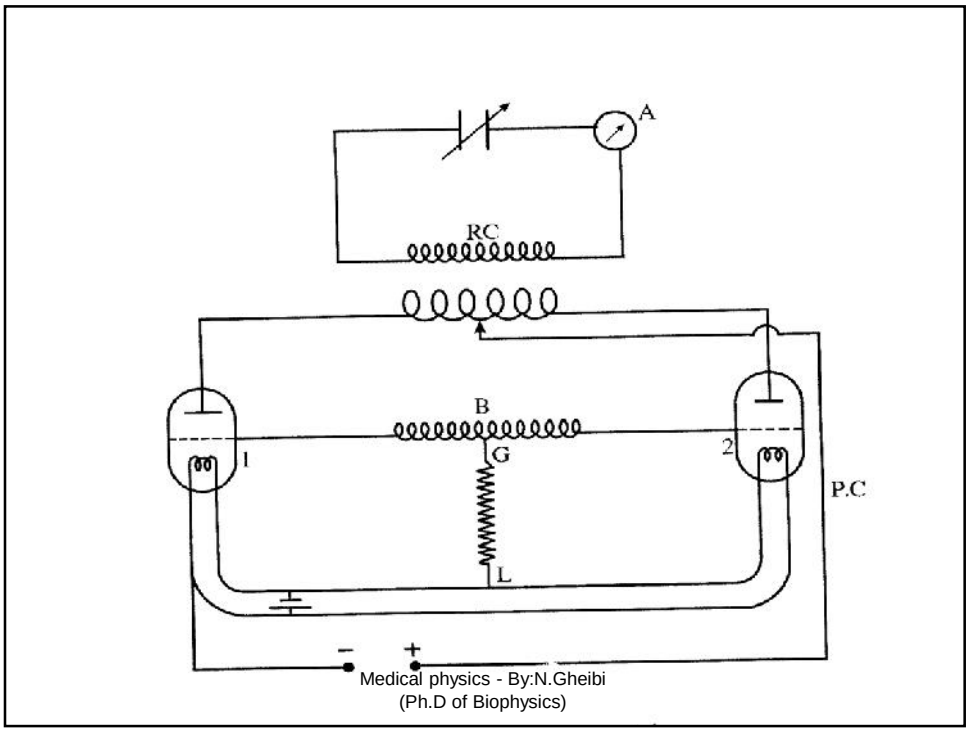

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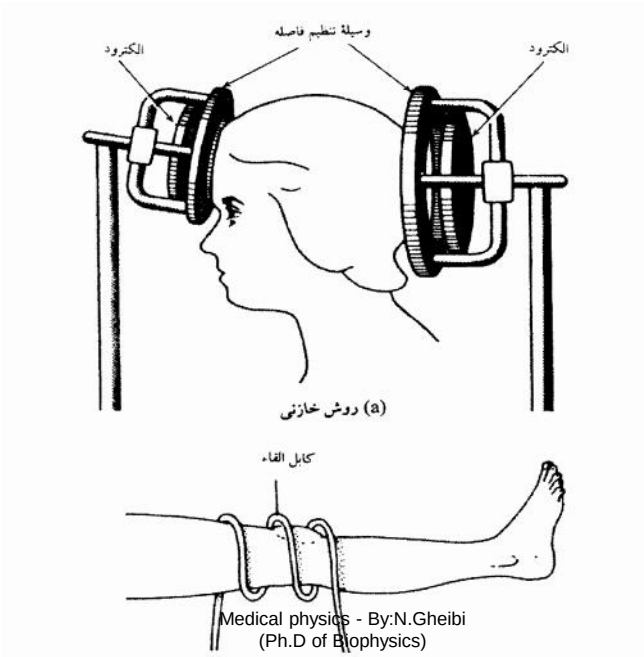

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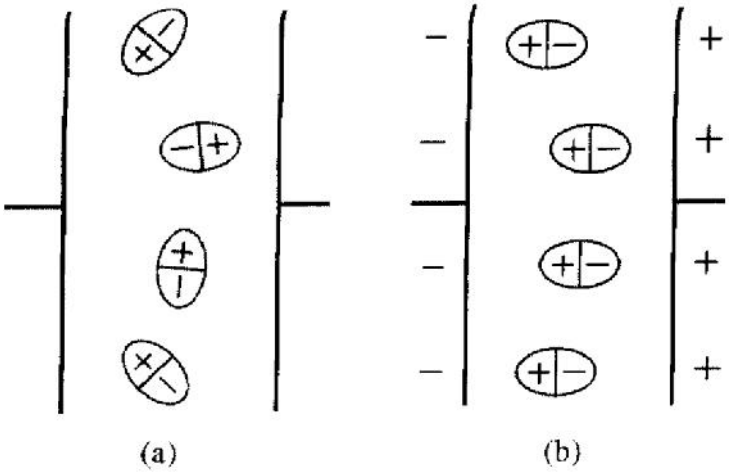

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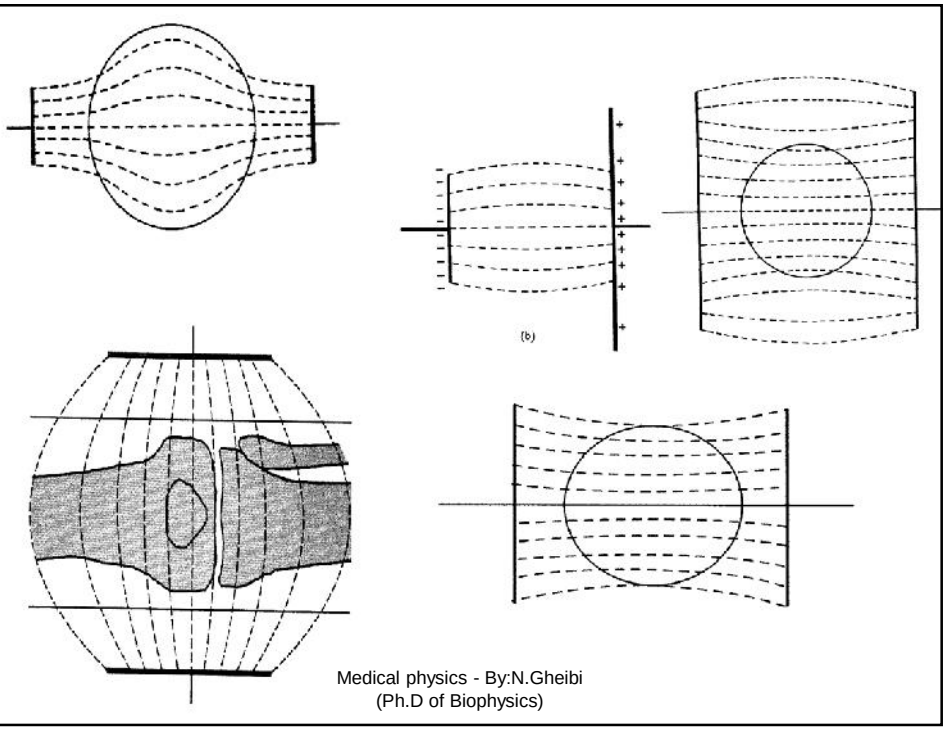

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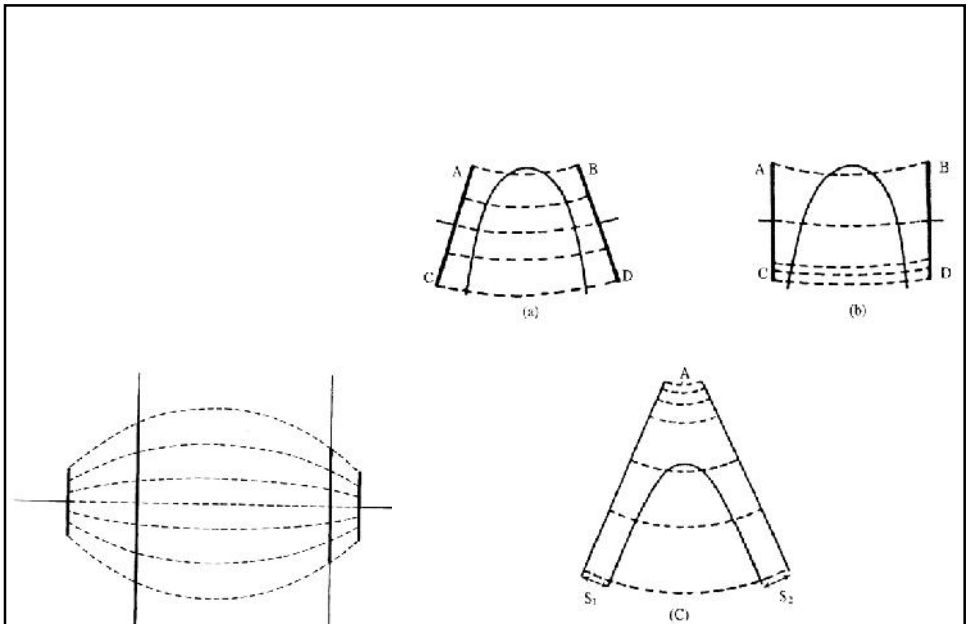

Medical physics - By:N.Gheibi
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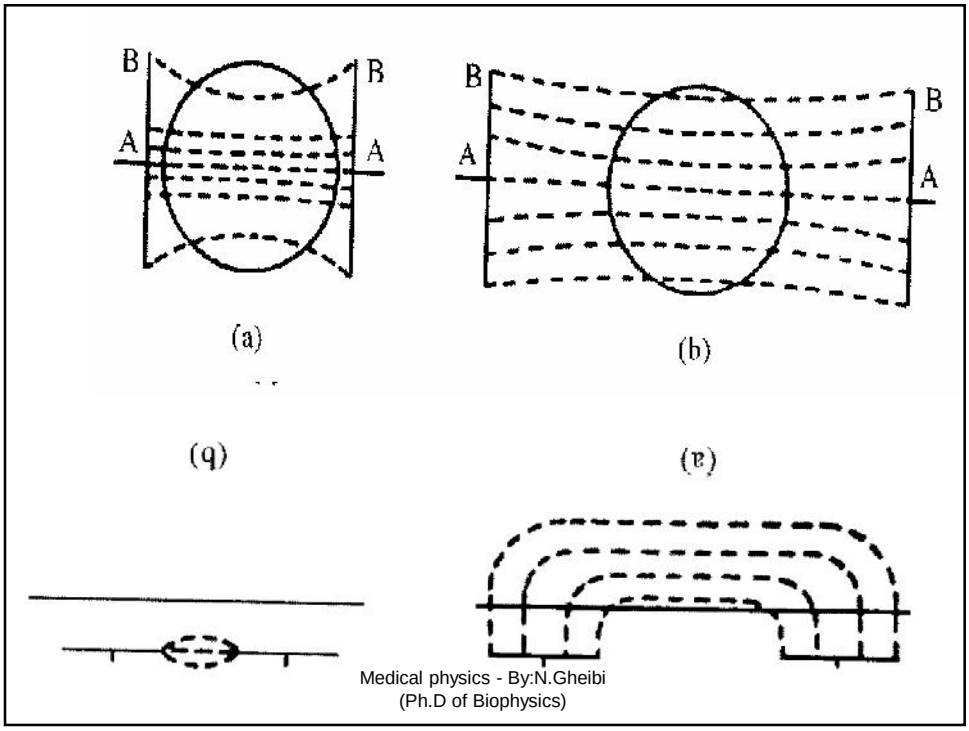

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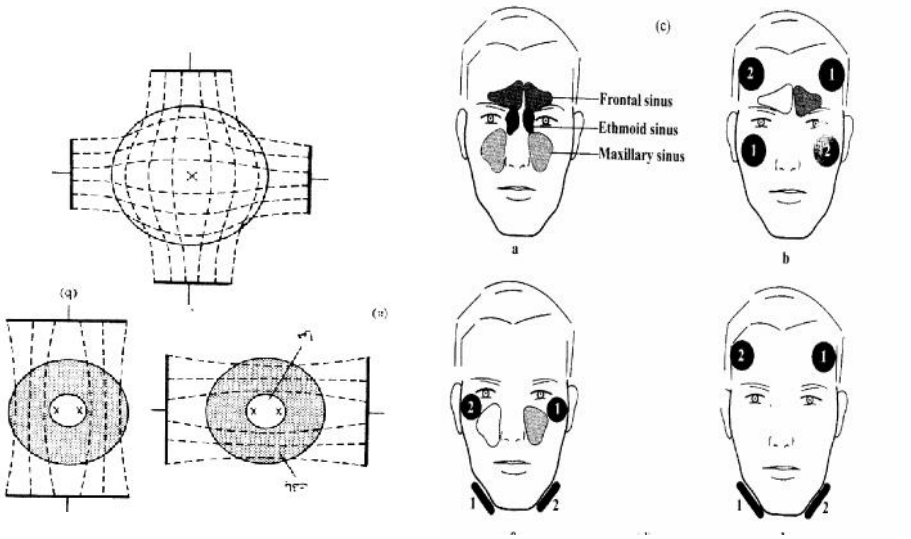
(Ph.D of Biophysics)



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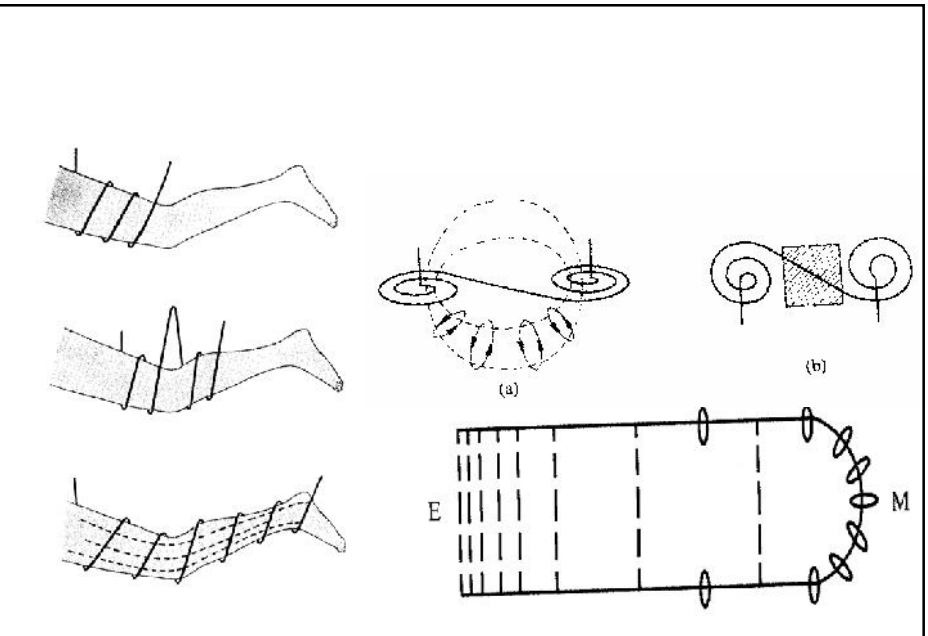

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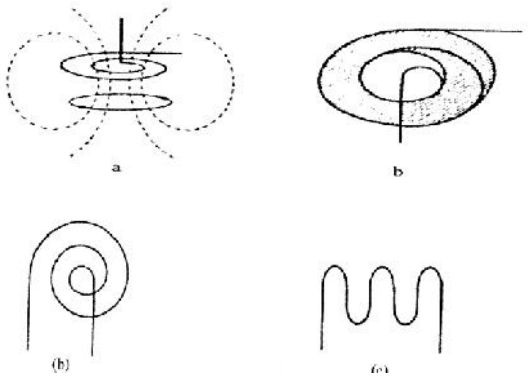

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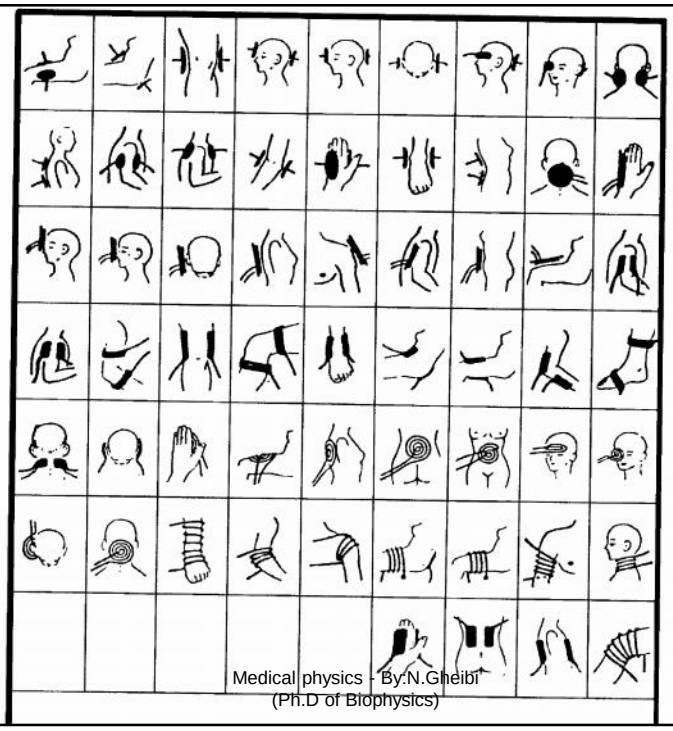

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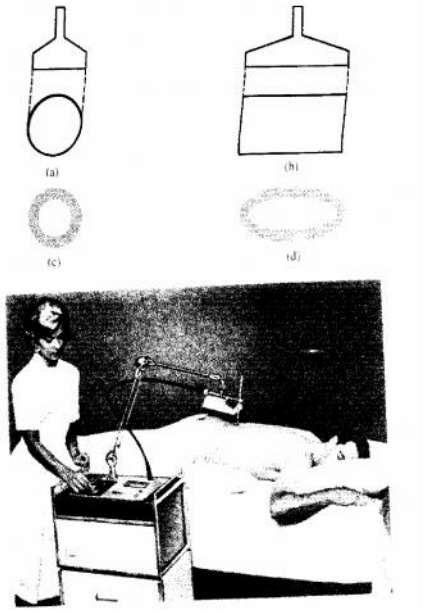

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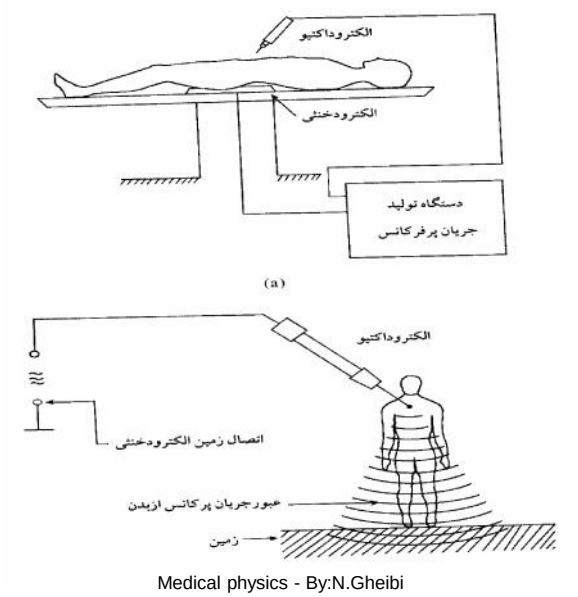

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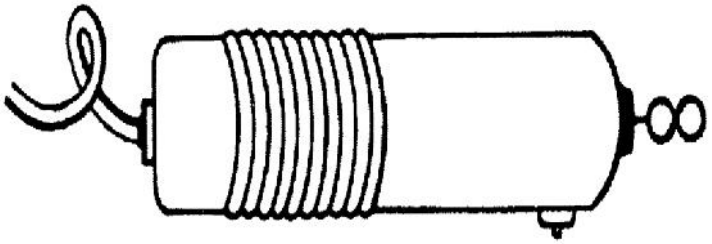

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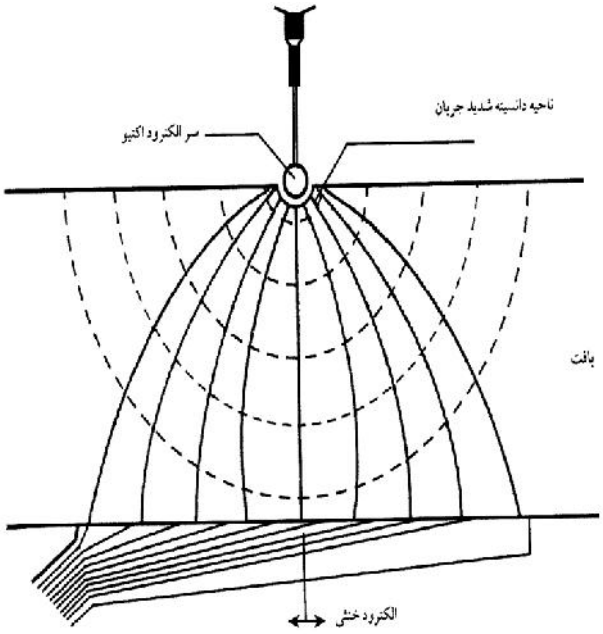

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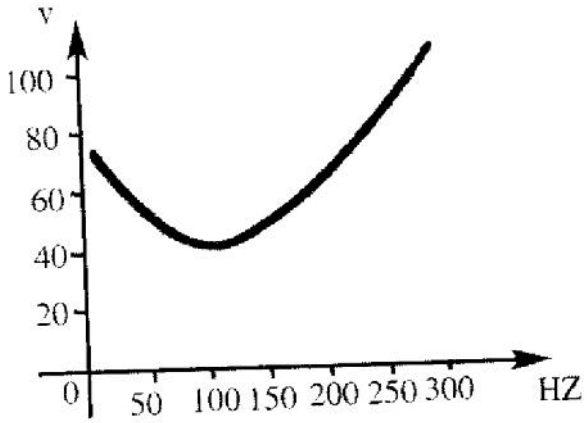

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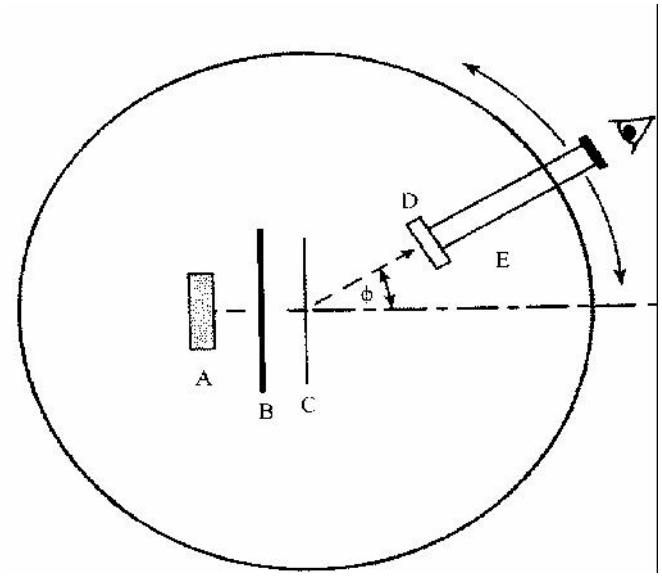

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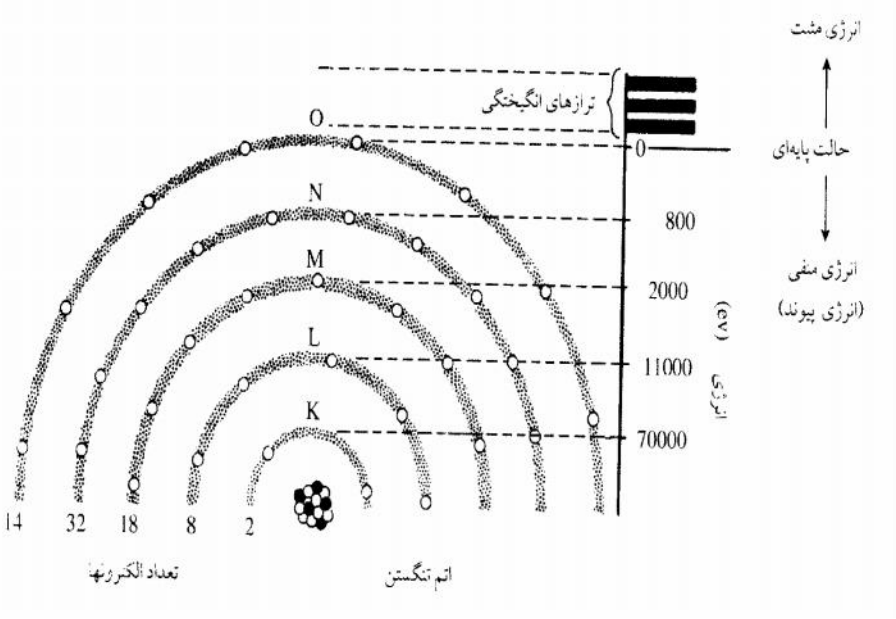

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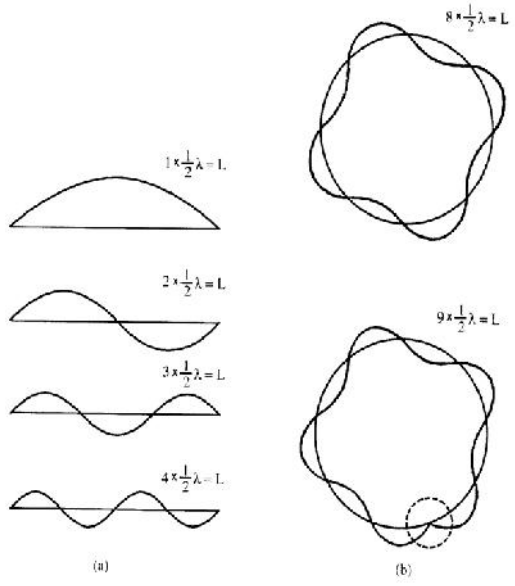

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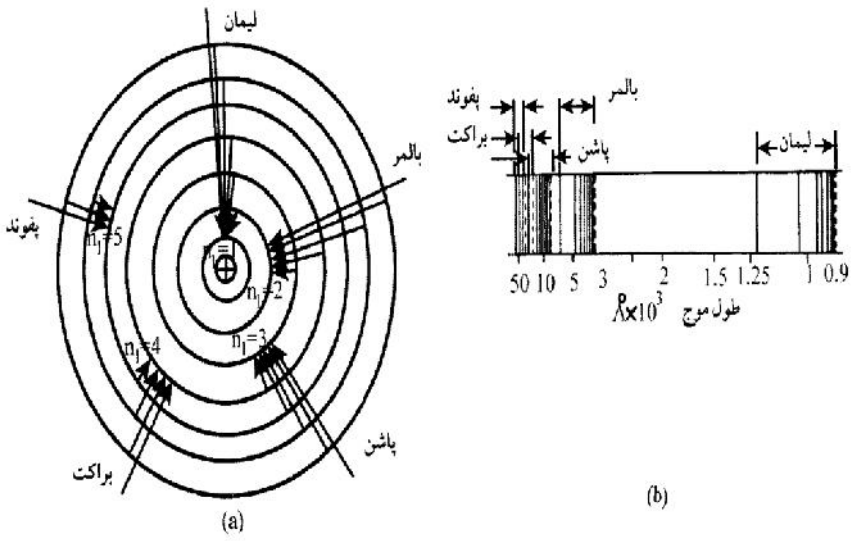

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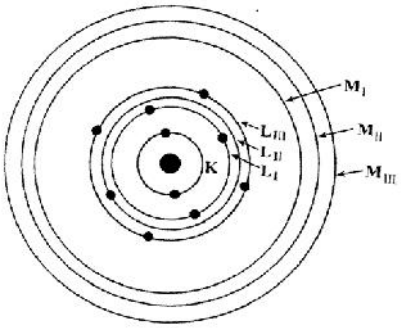

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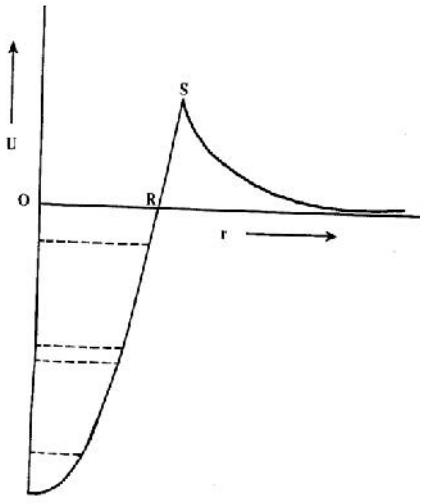

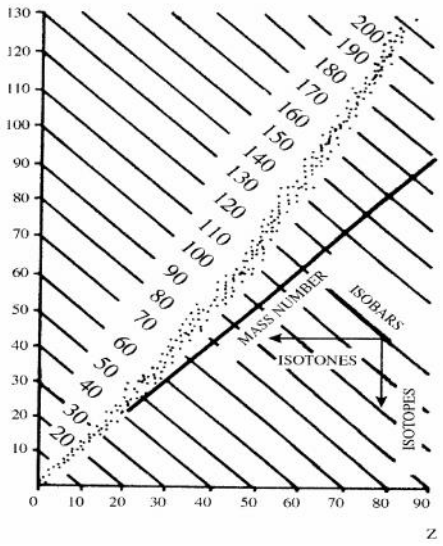

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$$p \rightleftharpoons n + \pi^+$$

$$n \rightleftharpoons p + \pi^-$$

$$p \rightleftharpoons p + \pi^\circ$$

$$n \rightleftharpoons n + \pi^\circ$$

$$^1_0n \rightarrow {}^1_1P + \bar{\beta} + {}^0_0\bar{\nu}$$

$$^1_1P \rightarrow {}^1_0n + \beta^+ + {}^0_0\nu$$

$$M - M' = \Delta m$$

اگر از رابطهٔ انیشتین $E = mc^2$ انرژی همسنگ Δm را بدست آوریم خواهیم دا

$$\Delta m = M - M' = 2(m_p + m_n + m_e) - m_2{}^4He$$

$$\Delta m = 4.030376 - 4.002603 = 0.030379 \text{ amu}$$

از برابری $E = mc^2$ انرژی جرم یک amu برابر 931.5 MeV است پس:

$$\Delta E = (0.030376)(931.5) = 28.28 \text{ MeV}$$

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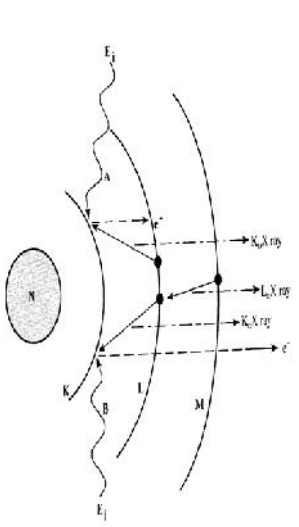

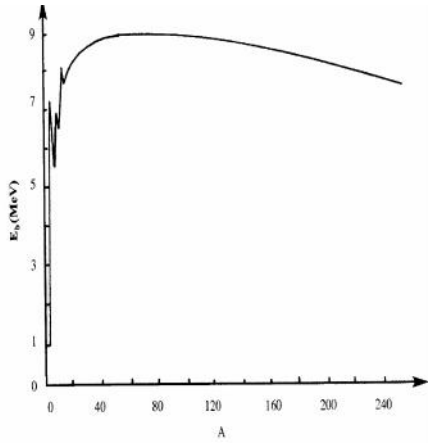

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واکنشهای هسته‌ای

$^{131}_{53}I \rightarrow {}^{131}_{54}X$ دگرگونی تک گام

$^{99}_{42}Mo \rightarrow {}^{99m}_{43}Tc \rightarrow {}^{99}_{43}Tc \rightarrow {}^{99}_{44}Ru$ دگرگونی در چند گام

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow A + B + (2-3){}^{1}_{0}n + 200\ MeV$$

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow {}^{131}_{53}I + {}^{102}_{39}Y + 3{}^{1}_{0}n + 200\ MeV$$

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow {}^{99}_{42}Mo + {}^{135}_{50}Sn + 2{}^{1}_{0}n + 200\ MeV$$

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow {}^{137}_{55}Cs + {}^{97}_{37}Rb + 2{}^{1}_{0}n + 200\ MeV$$

$$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n + 3.25\ MeV$$

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + 17.6\ MeV$$

$$^{2}_{1}H + {}^{3}_{2}H \rightarrow {}^{4}_{2}He + {}^{1}_{1}p + 18.3\ MeV$$

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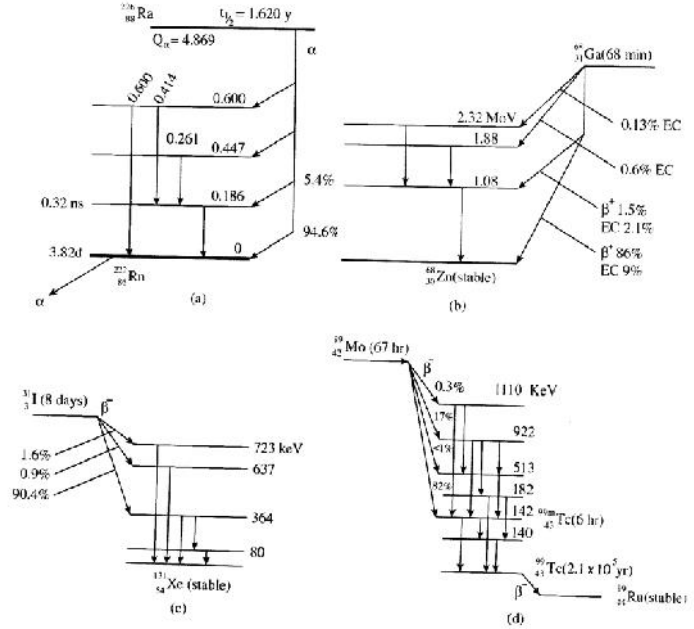

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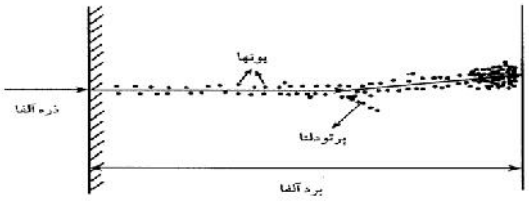
$$^{A}_{Z}X \dashrightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}\alpha + \gamma + Q$$

$$^{226}_{88}Ra \xrightarrow{1622Y} {}^{222}_{86}Rn + {}^{4}_{2}He + \gamma \left(\begin{matrix}\gamma_1\ 98\% \\ \gamma_2\ 1.2\%\end{matrix}\right)$$

$$^{222}_{86}Rn \dashrightarrow {}^{218}_{84}Po + \alpha + \gamma$$



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(برد میانگین)

پرتو	نشانه	بار الکتریکی	انرژی	هوا	آب	یونش نسبی ویژه
آلفا	α	+2	3-9 Mev	3 - 9 cm	25 - 45 μm	2500
بتا	β^-	-1	0-3 Mev	0 - 10 cm	5 - 1 mm	100
پوزیترون	β^+	+1	0-3Mev	0 - 10 cm	5 - 1 mm	100
نوترون	n	o	0-10 Mev	1 - 100 m	0 - 1 m	0.1
پرتوایکس	x	o	10-200 Kev	cm - 20 m	mm - cm	1
پرتوگاما	γ	o	kev-10Mev	cm - 100 m	mm -10 cm	1

جدول (۲-۴)

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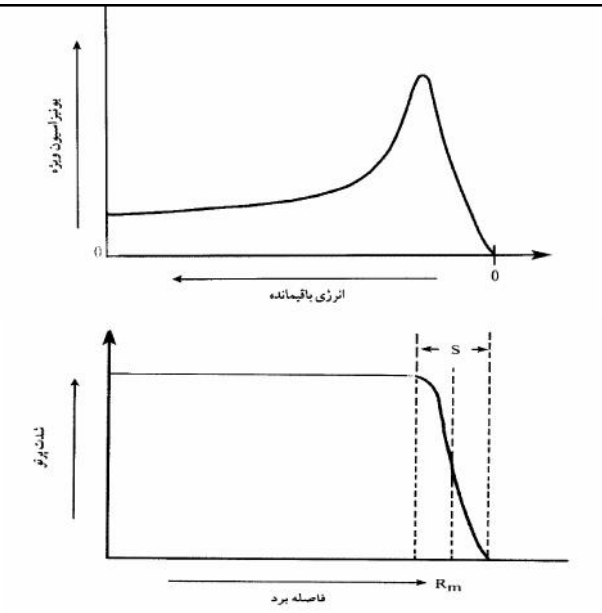

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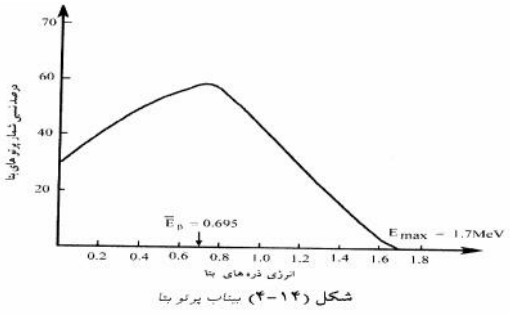
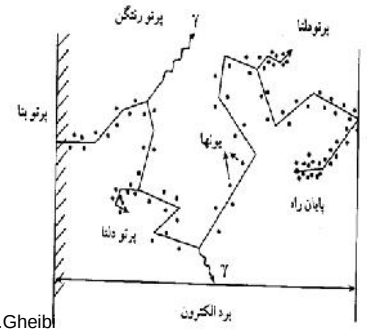
$$^{A}_{Z}X \longrightarrow {}_{Z+1}{}^{A}Y + {}^{0}_{-1}\beta^{-} + {}^{0}_{0}\bar{\nu} + \gamma + Q$$

$$^{32}_{15}P \longrightarrow {}^{32}_{16}S + \beta^{-} + {}^{0}_{0}\bar{\nu} + \gamma$$

$$^{131}_{53}I \longrightarrow {}^{131}_{54}Xe + \bar{\beta} + {}^{0}_{0}\bar{\nu} + \gamma$$



شکل (۱۴-۴) بیتاب پرتو بتا

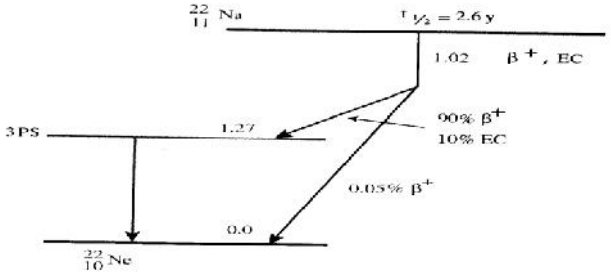


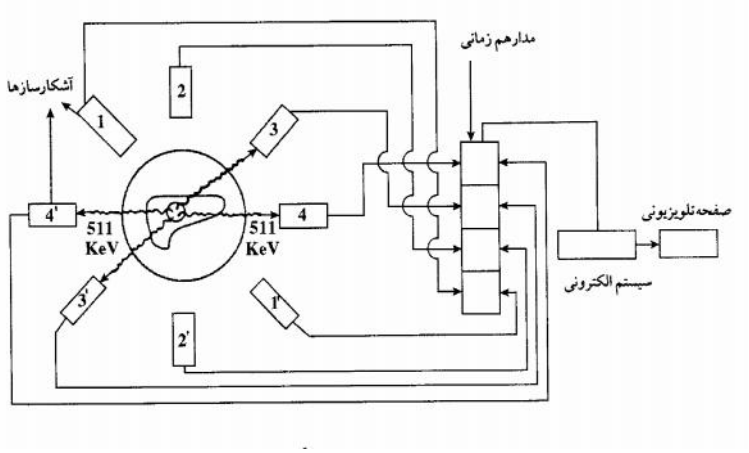
$$^{A}_{Z}X \longrightarrow {}_{Z-1}{}^{A}Y + \beta^{+} + {}^{0}_{0}\nu + \gamma + Q$$

$$^{22}_{11}Na \longrightarrow {}^{22}_{10}Ne + \beta^{+} + {}^{0}_{0}\nu + \gamma$$

$$^{68}_{31}Ga \longrightarrow {}^{68}_{30}Zn + \beta^{+} + {}^{0}_{0}\nu + \gamma$$

$$^{1}_{1}p \longrightarrow {}^{1}_{0}n + e^{+} + {}^{0}_{0}\nu + Q$$





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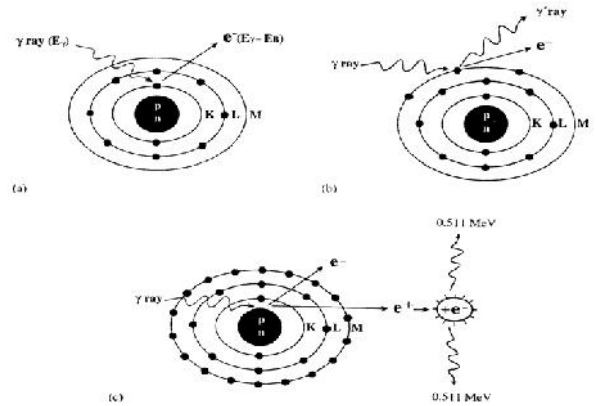
$$e^- + {}^{A}_{Z}X \longrightarrow {}^{A}_{Z-1}Y + {}^{0}_{0}\nu + \gamma + Q$$

$${}^{125}_{53}I + \bar{e} \longrightarrow {}^{125}_{52}Te + {}^{0}_{0}\nu$$



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معادله‌های دگرگونی یا اکتیویته

یکای پیشین	یکای امروزی (SI)
1 Ci	37 GBq
1 mCi	37 MBq
1 μCi	37 KBq

$$\Delta N = -\lambda.\Delta t$$

$$dN = -\lambda N dt \qquad \int \frac{dN}{N} = \int -\lambda dt \qquad LN_0 = +C$$

$$\frac{dN}{dt} = -\lambda N \qquad LN = -\lambda t + C \qquad LN = -\lambda t + LN_0$$

$$\lambda = \frac{\Delta N}{N} \cdot \frac{1}{\Delta t} \qquad L\frac{N}{N_0} = -\lambda t \longrightarrow \frac{N}{N_0} = e^{-\lambda t}$$

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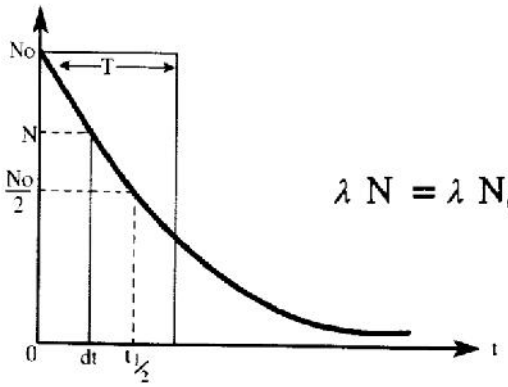

$$N' = N_0(1 - e^{-\lambda t})$$

$$A = \lambda N$$

$$\lambda N = \lambda N_0 e^{-\lambda t} \Rightarrow A = A_0 e^{-\lambda t}$$

$$R = R_0 e^{-\lambda t}$$

$$\frac{N}{N_0} = \frac{A}{A_0} = \frac{R}{R_0} = e^{-\lambda t}$$

$$\frac{1}{T_e} = \frac{1}{T_p} + \frac{1}{T_b} \text{ یا } \Rightarrow T_e = \frac{T_p \times T_b}{T_p + T_b}$$ نیم عمر مؤثر

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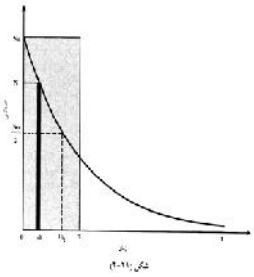


$$A \xrightarrow{\lambda 1} B \xrightarrow{\lambda 2} \dots \quad \text{باید}$$

$$N_a = N_a^o\, e^{-\lambda_a t}$$

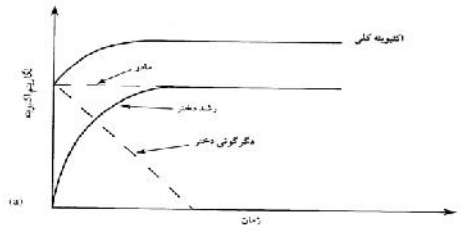
$$\frac{dN_b}{dt} = \lambda_a N_a - \lambda_b N_b \longrightarrow \frac{dN_b}{dt} = \lambda_a N_a^o\, e^{-\lambda_a t} - \lambda_b N_b$$

$$N_b = \frac{\lambda_a}{\lambda_b - \lambda_b} N_a^o \left(e^{-\lambda_a t} - e^{-\lambda_b t}\right)$$ ترازمندی پایدار

$\lambda_1 \gg \lambda_2$ و $T_1 \gg T_2$ ، $N_b = \frac{\lambda_a}{\lambda_b} \times N_o^a\, e^{-\lambda a t}$

$$^{226}Ra \xrightarrow[t_{1/2} = 1620\ yr]{\lambda_1 = 1.3 \times 10^{-11}\ sec^{-1}} {}^{222}Rn \xrightarrow[t_{1/2} = 3.8\ yr]{\lambda_2 = 2.1 \times 10^{-6}\ sec^{-1}} {}^{218}Po$$

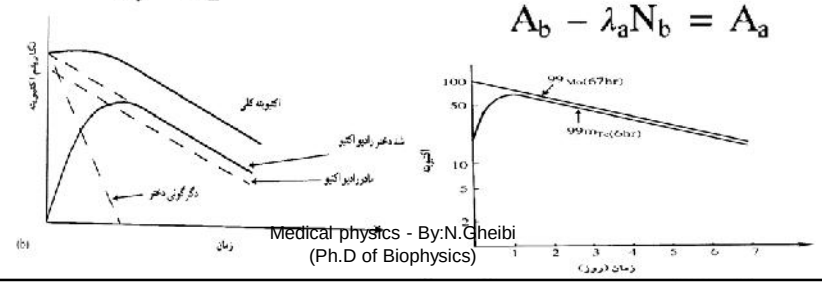
$$N_b = \frac{\lambda_a}{\lambda_b} \times N_a^o e \Rightarrow \lambda_b N_b = \lambda_a N_a$$



ترازمندی گذرا

$$N_b = \frac{\lambda_a}{\lambda_b - \lambda_a} N_o^a\, e^{-\lambda a t} \longrightarrow \lambda_b N_b - \lambda_a N_b = \lambda_a N_a$$

$$A_b - \lambda_a N_b = A_a$$



روش تشخیص	رادیو دارو	اندازه اکتیویته کاربردی	دوز گنادها (mGy)
اسکن مغز	^{99m}Tc pertechnetate	500 MBq (≈ 15 mCi)	4
اسکن کبد	^{99m}Tc sulfur colloid	150 MBq (≈ 4 mCi)	0.85
اسکن شش	^{99m}Tc macroaggregated	100 MBq (≈ 3 mCi)	0.3
اسکن استخوان	^{99m}Tc pyrophosphate	500 MBq (≈ 15 mCi)	4
رنوگرام	^{131}I hipuric acid	8 MBq (≈ 200 μ Ci)	0.2
جذب ید	^{131}I sodium iodide	300 KBq (≈ 8μ CI)	0.6
اسکن تیروئید	^{99m}Tc pertechnetate	150 MBq (≈ 4 mCi)	0.8
کلیه و مغز	Diethylen triamin penta acetic acid(DTPA)	550 MBq (≈ 17 mCi)	< CGy
کلیه	Glucoheptonate	500 MBq (≈ 15 mCi)	< CGy
کبد و کانالهای صفرا	Dimethylacetanilide Iminodiacetic acid (HIDA)	500 MBq (15 mCi)	< CGy
قلب و تومورها	Methoxy isobutyl isonitrile (Mibi)	500 MBq	< CGy

$$^{99}Mo\ (67\ hrs) \xrightarrow{\beta} {}^{99m}Tc\ (6\ hrs)$$

$$^{132}Te\ (78\ hrs) \xrightarrow{\beta} {}^{132}I\ (2.3\ hrs)$$

$$^{87}Y\ (80\ hrs) \xrightarrow{\beta} {}^{87}Sr\ (2.8\ hrs)$$

$$^{68}Ge\ (271\ ds) \xrightarrow{\beta} Ga\ (67\ min)$$

$$^{81}Rb\ (4.6\ hrs) \xrightarrow{\beta} {}^{81\ m}Kr\ (13\ Sec)$$

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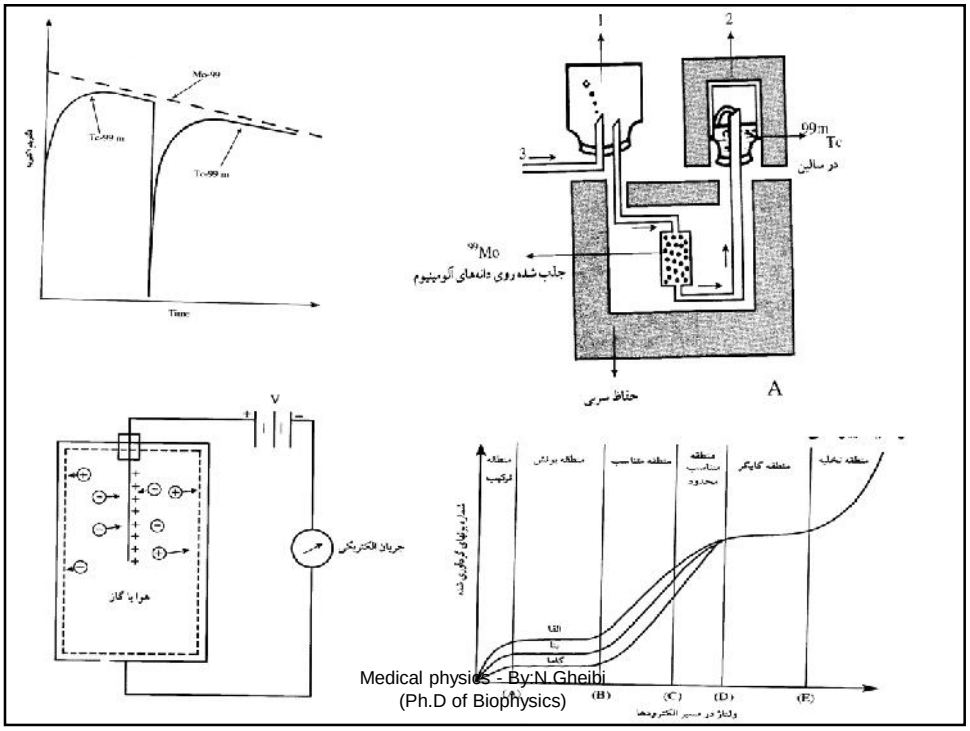

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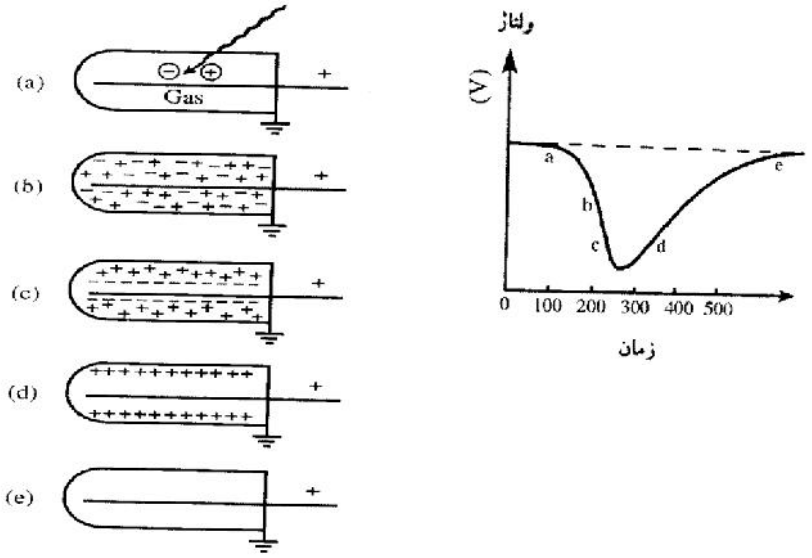

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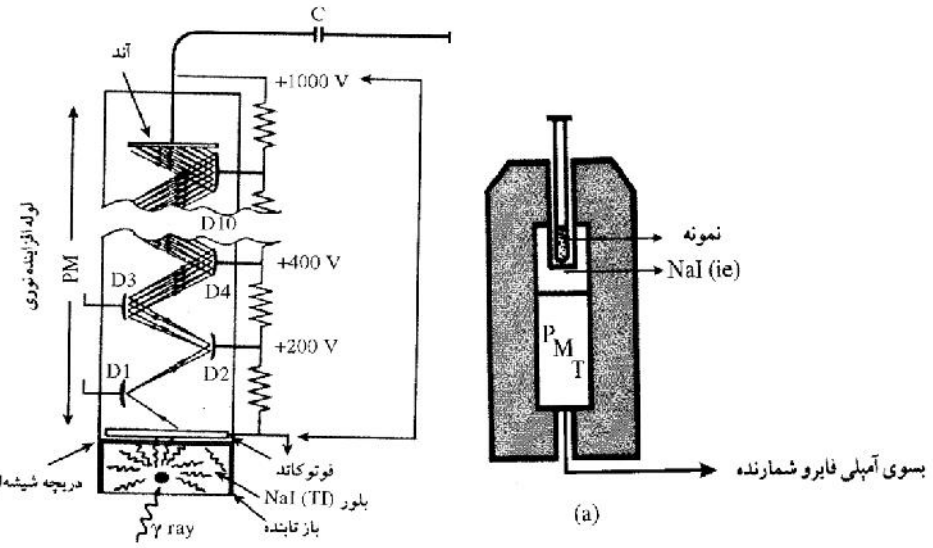

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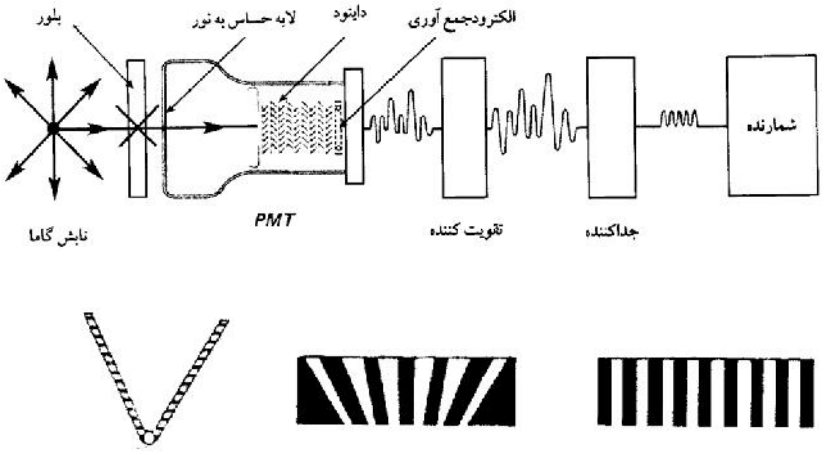

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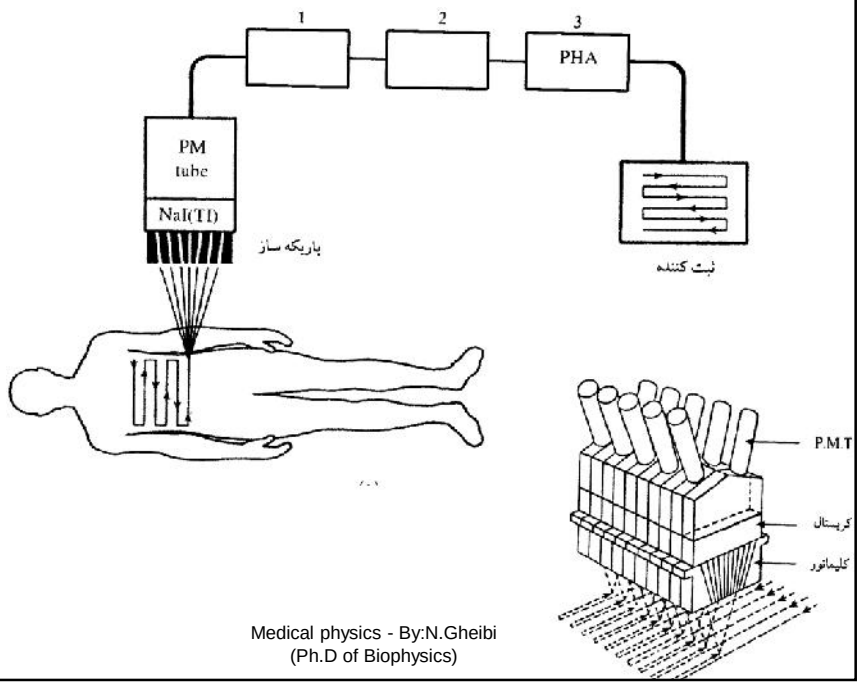

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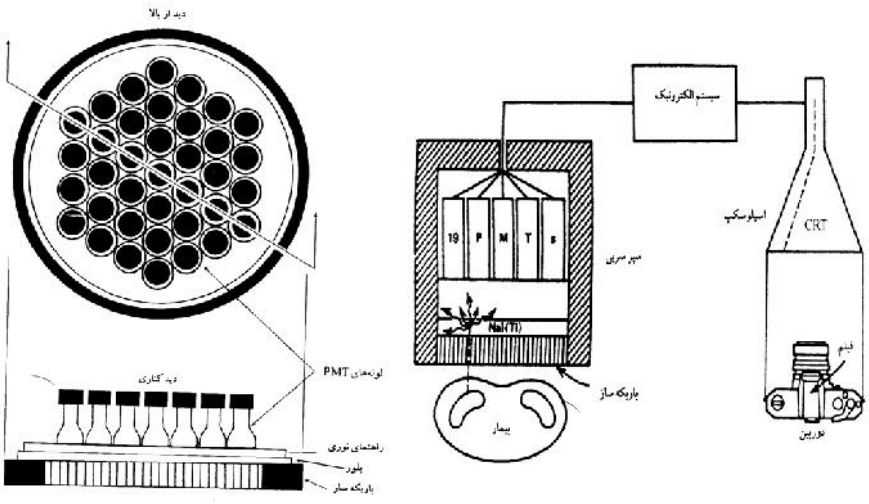

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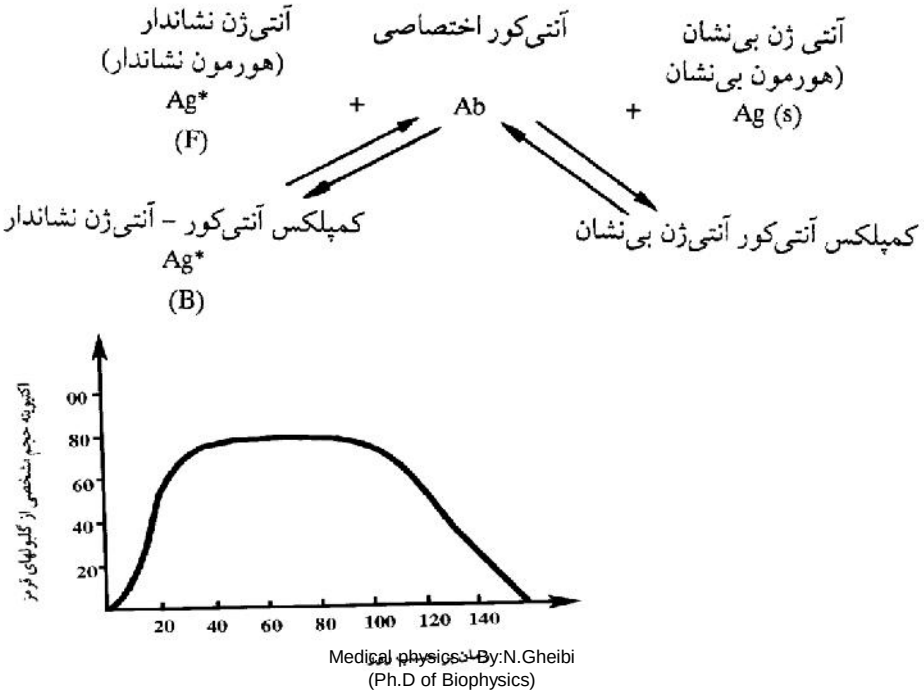

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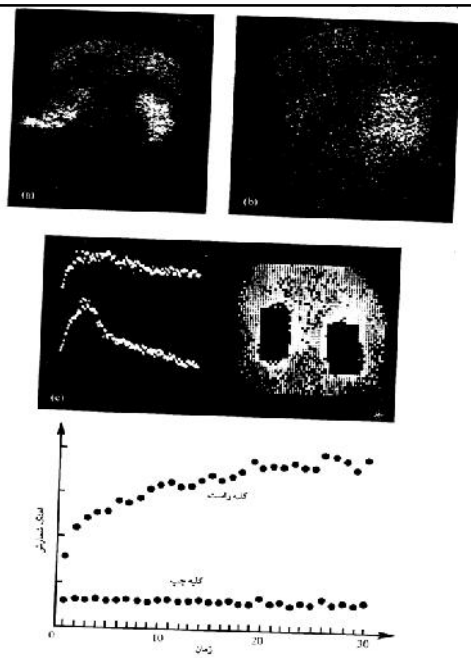

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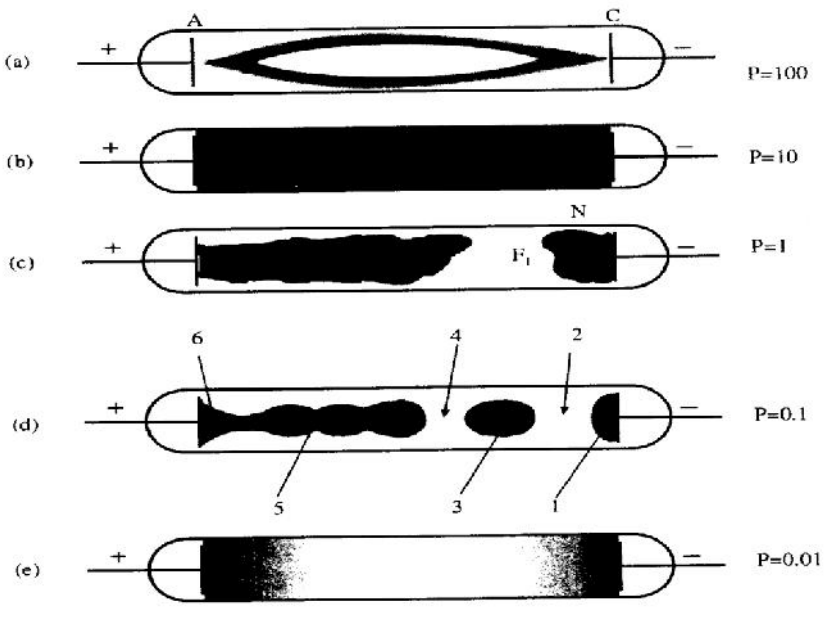

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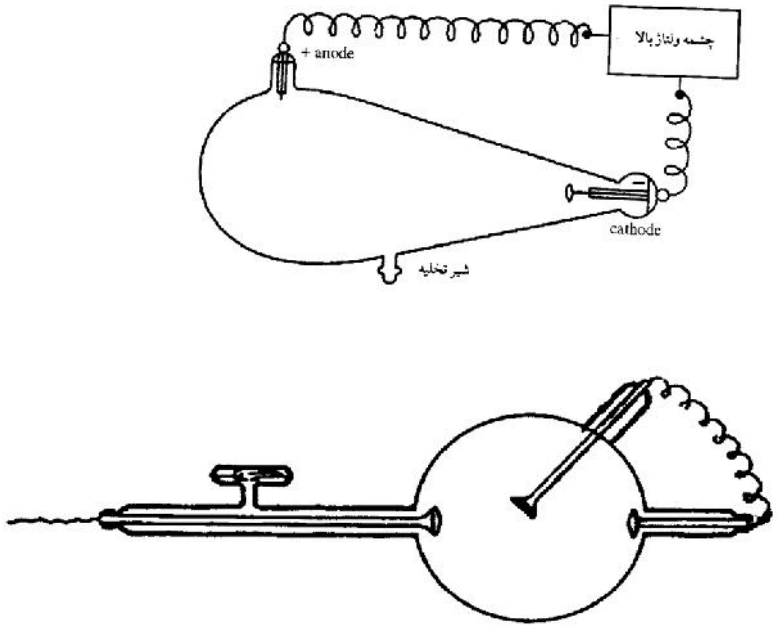

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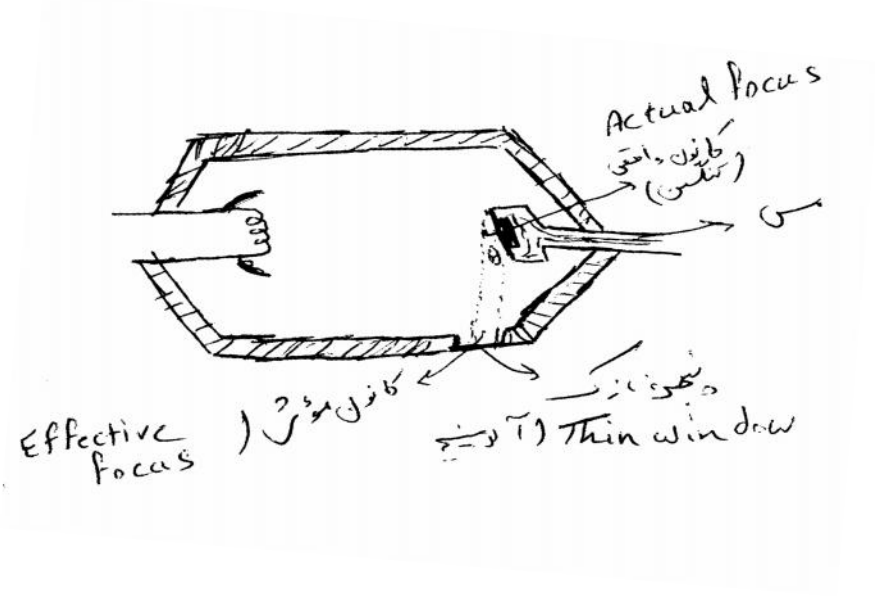

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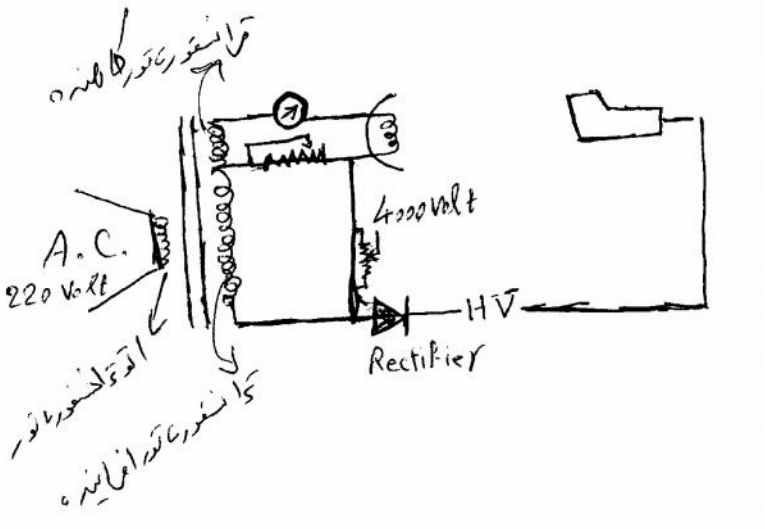

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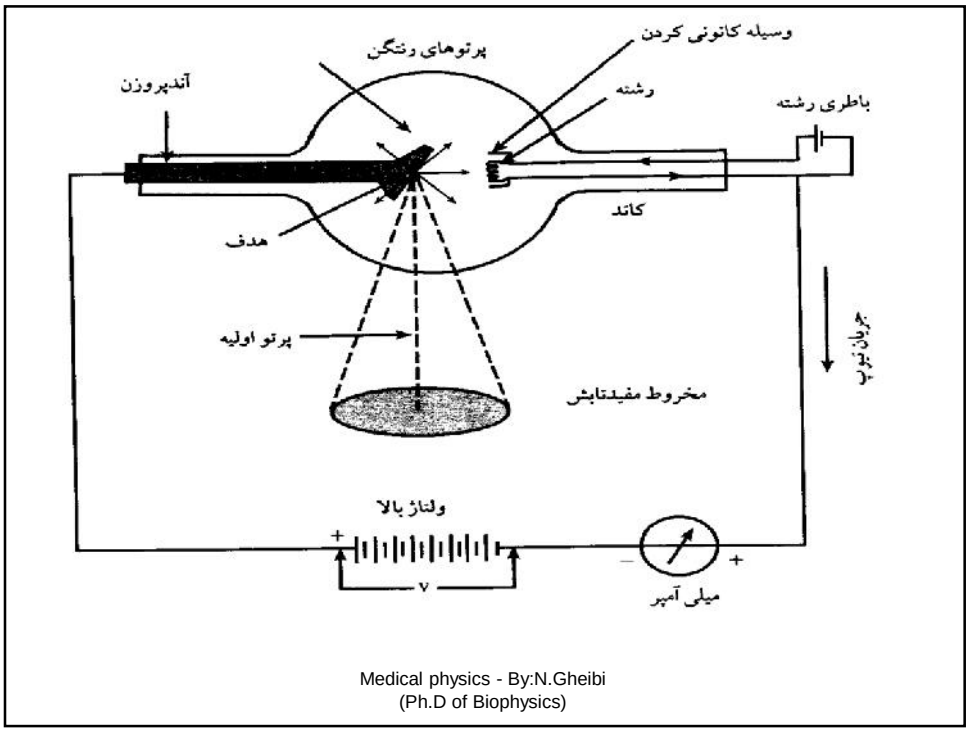

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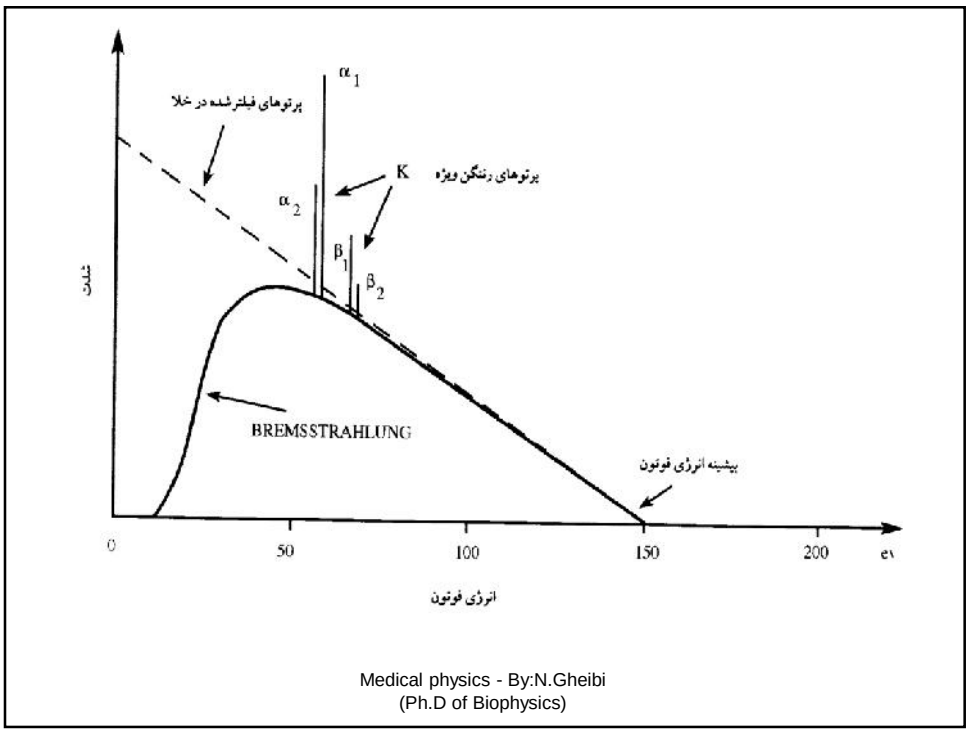

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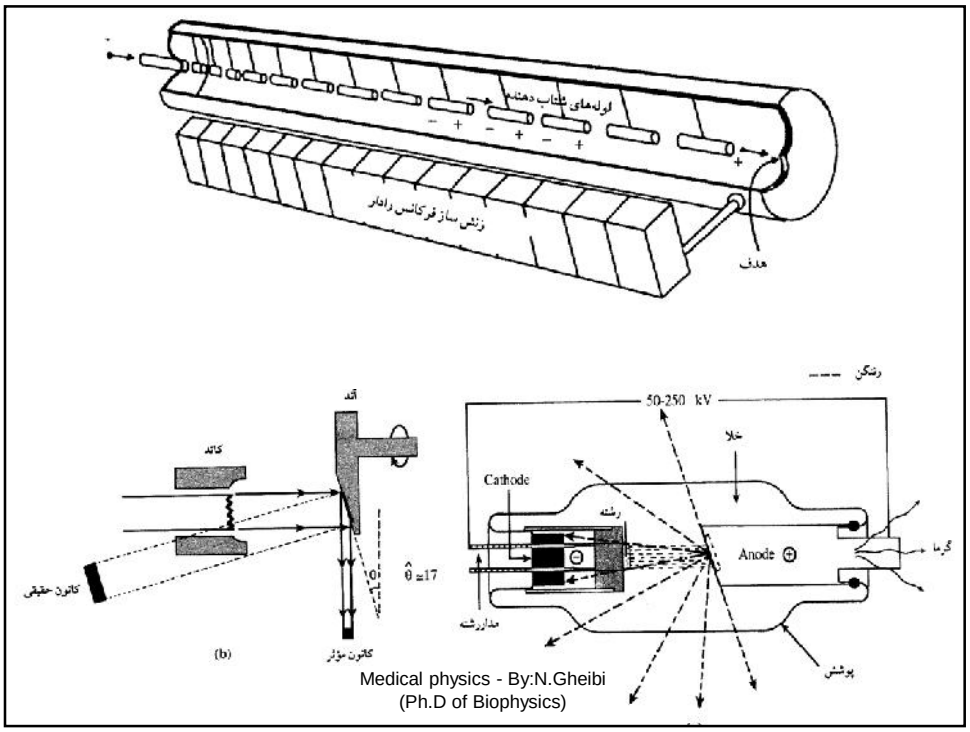
لوله‌های شتاب دهنده
ژنراتور سازفرکانس رادار
هدف
رشته
50-250 kV
خلا
Cathode
Anode
گرما
پوشش
مدار رشته
آند
کاتد
کاتون حقیقی
کاتون مؤثر
(b)
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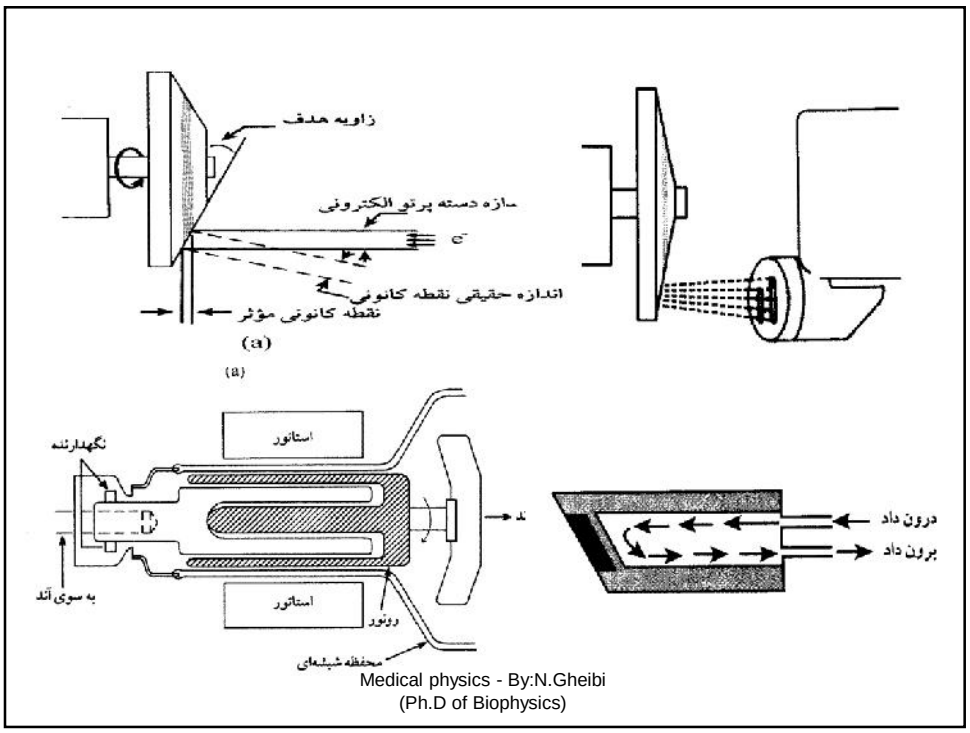
زاویه هدف
سازه دسته پرتو الکترونی
اندازه حقیقی نقطه کانونی
نقطه کانونی مؤثر
(a)
(a)
نگهدارنده
استاتور
استاتور
روتور
به سوی آند
محفظه شیشه‌ای
درون داد
برون داد
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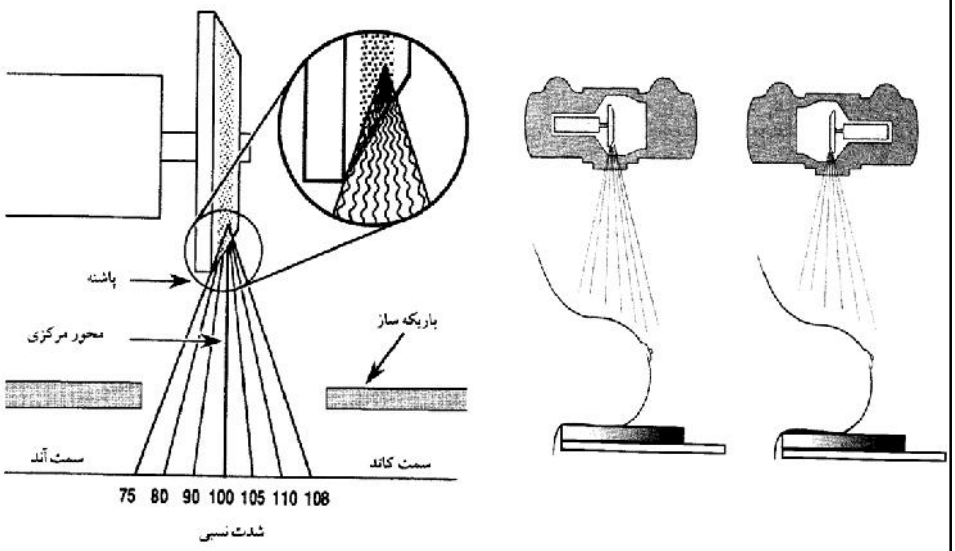

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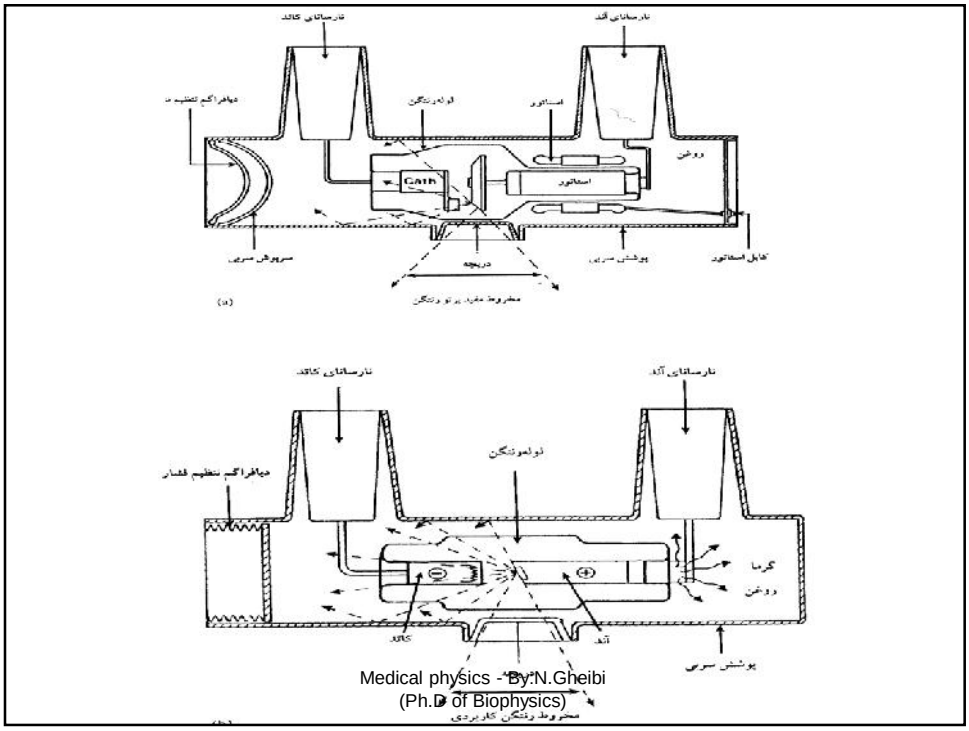

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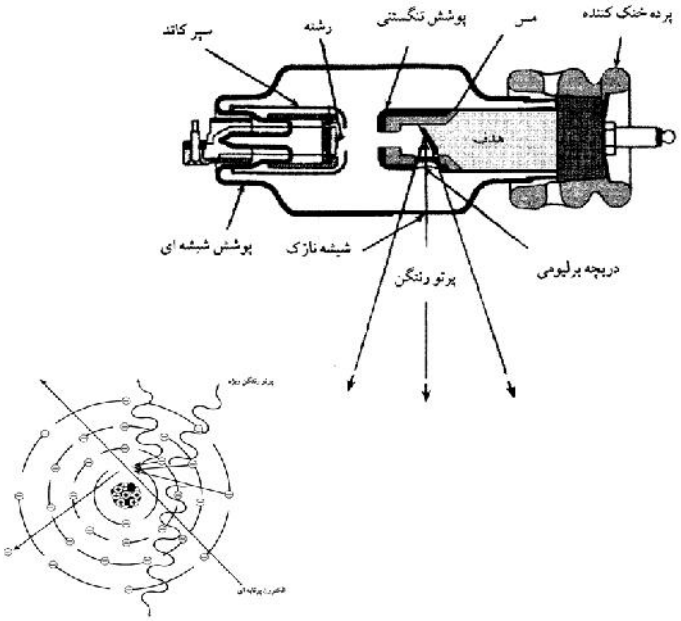

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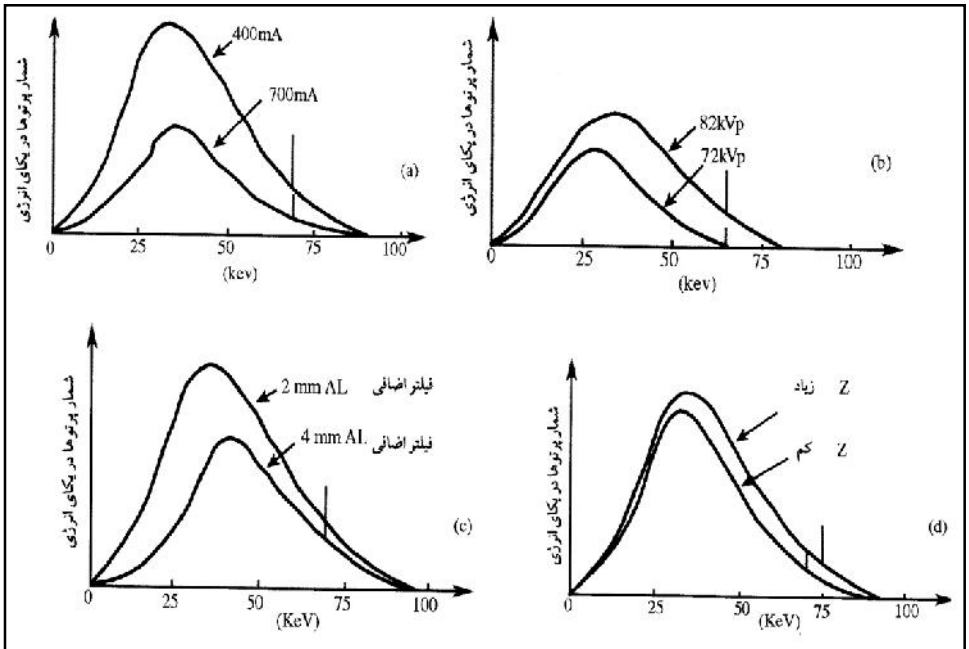

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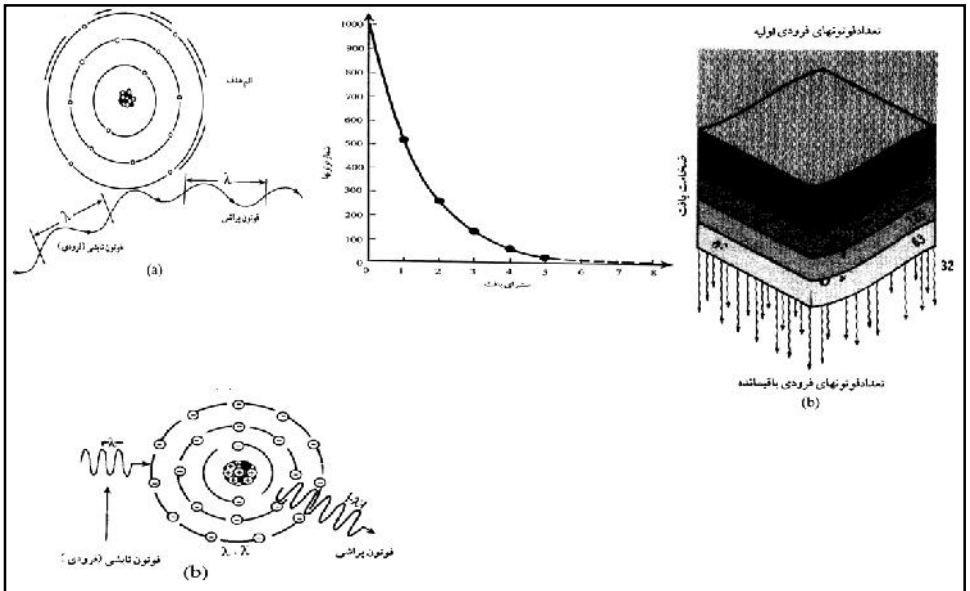

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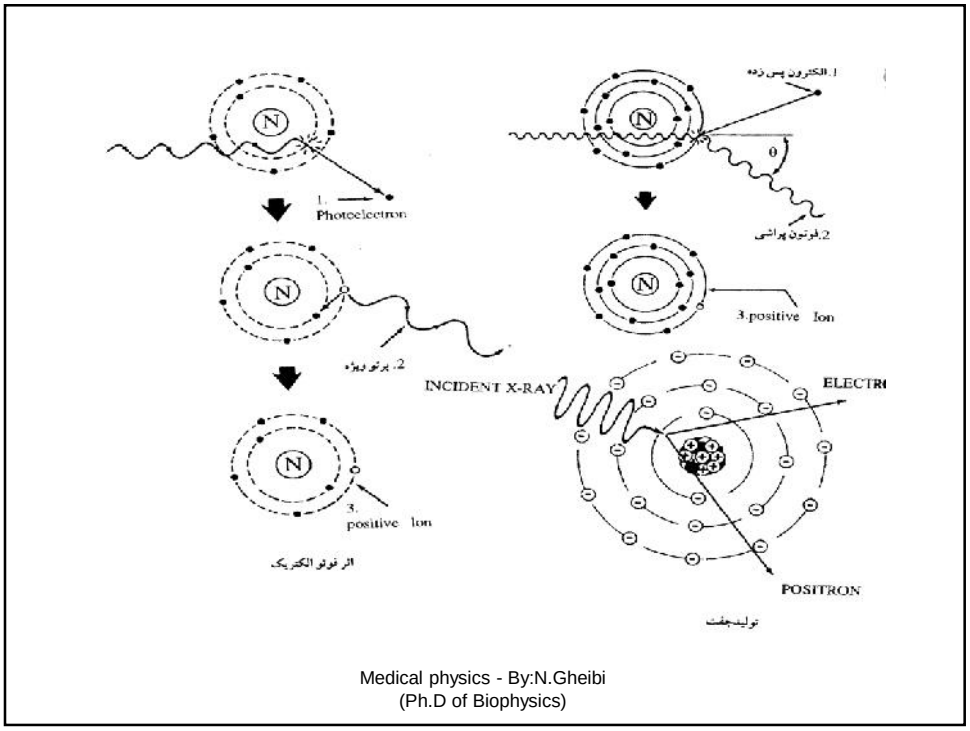

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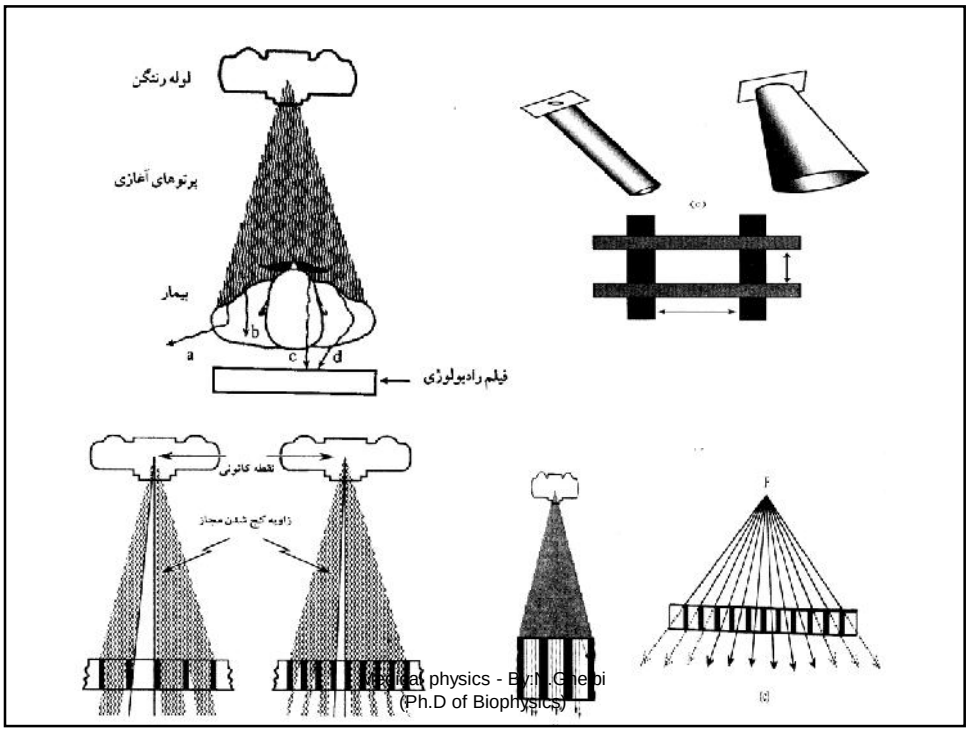

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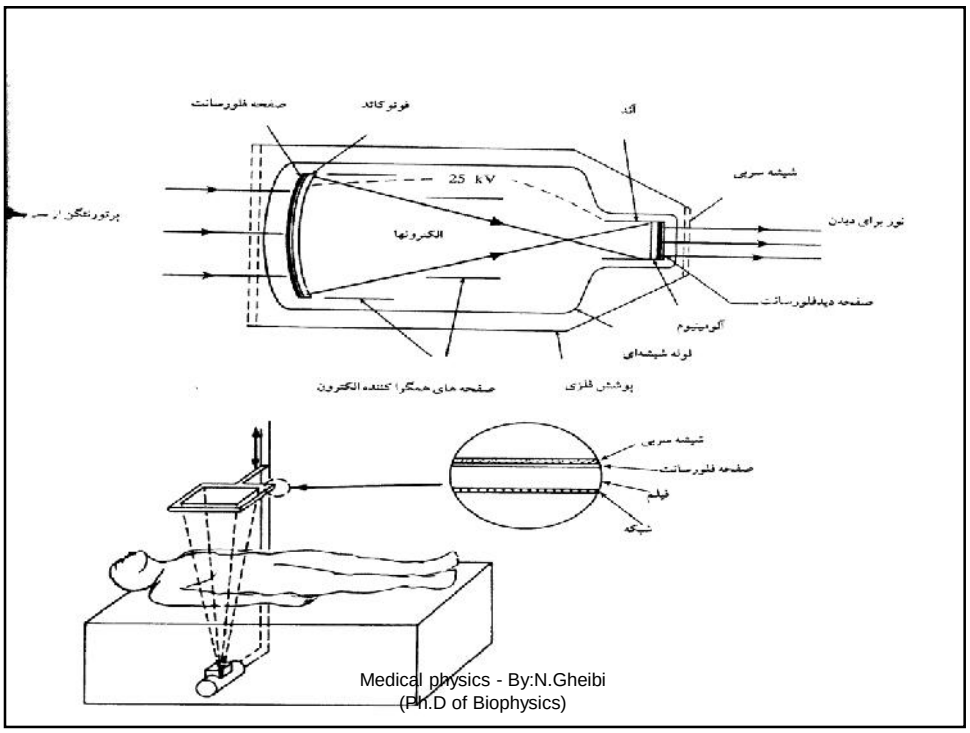

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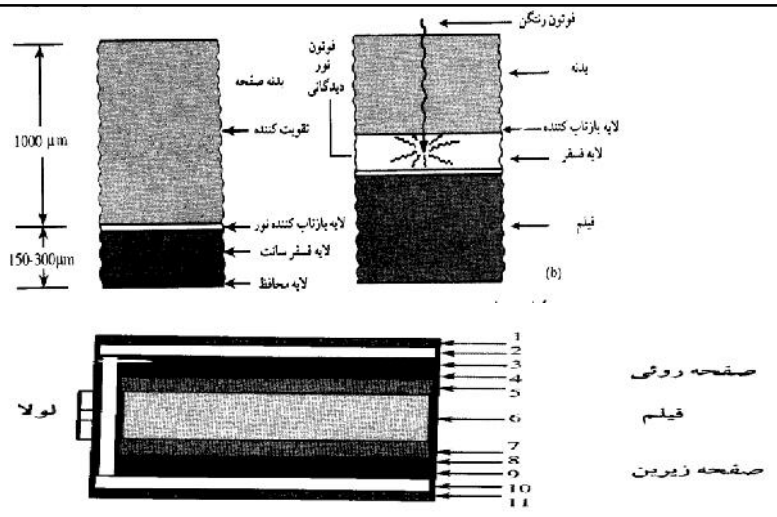

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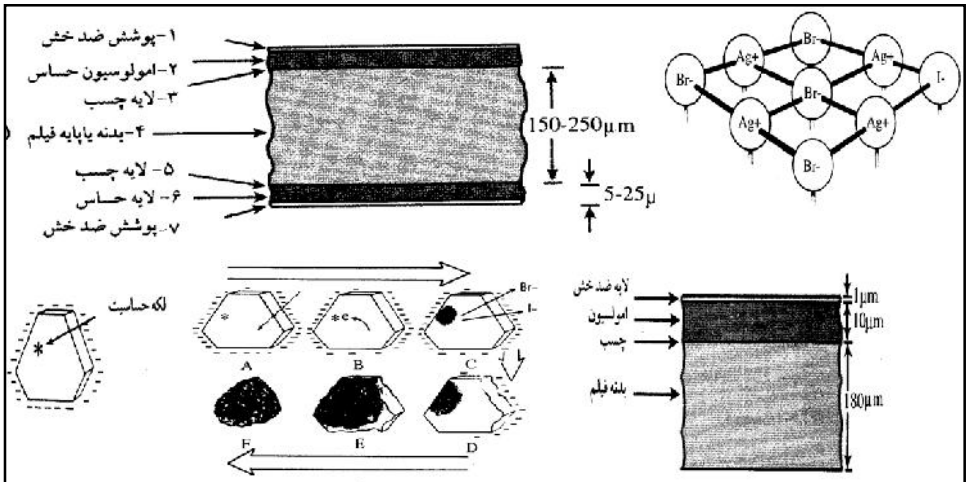

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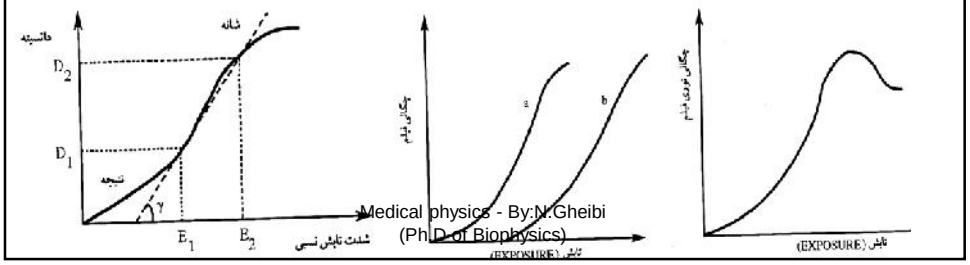
$$\text{Density} = \frac{(KV_p)^n \times mas}{f^2}$$

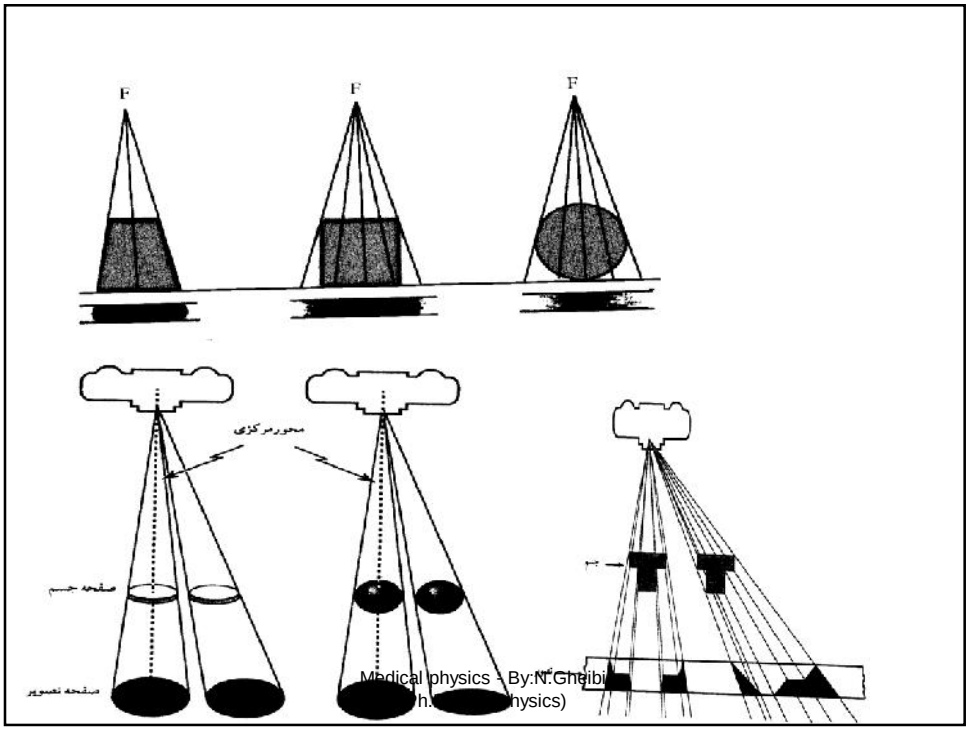
$$D = \log \frac{I_o}{I} \qquad \text{Contrast } (C) = D_2 - D_1$$

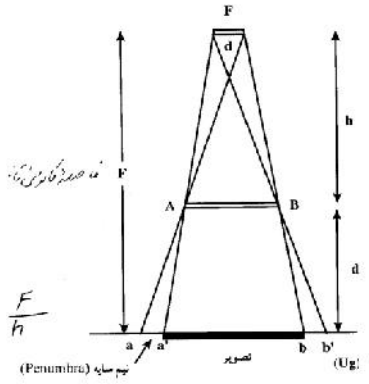
$$\text{Contrast} = D_2 - D_1 = \log\left(\frac{I_o}{I_2}\right) - \log\left(\frac{I_o}{I_1}\right)$$

$$\text{Contrast} = -(\log I_2 - \log_1) \qquad \gamma = \frac{D_2 - D_1}{\log E_2 - \log E_1}$$

$$\text{Contrast } (C) = D_2 - D_1 = \gamma\, 0.4343(\mu_1 - \mu_2)X$$







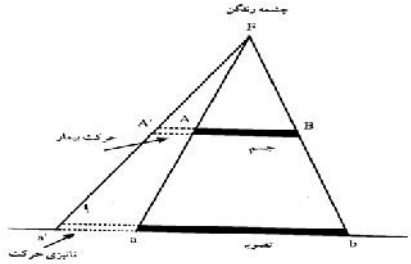
U_g در اثر فاکتورهای زیر افزایش می‌یابد

الف- افزایش اندازهٔ مؤثر نقطهٔ کانونی (a)

ب- کاهش فاصله کانون دستگاه تا فیلم (f)

ج- افزایش فاصله بیمار تا فیلم (d)

ناتیزی حرکت از فرمول $U_m = \frac{f}{f-d} v.t$



. برای کاهش U_m باید:

۱- فاصلهٔ f را افزایش داد.

۲- d را کاهش داد.

۳- سرعت حرکت بیمار و زمان تابش را کوچک کرد.

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$$RBE = \frac{\text{دوز پرتو استاندارد برای ایجاد یک تأثیر بیولوژیکی مشخص}}{\text{دوز پرتو دیگر برای ایجاد همان تأثیر زیستی}}$$

LET (keV/μ)	RBE
3.5 (keV/μ)	1
4.3 (keV/μ)	1.5
15 (keV/μ)	3.5
36 (keV/μ)	7.5
230 (keV/μ)	15

$$D_E = D_{\text{(دوز جذب شده)}} \times QF$$

$$SV = Gy \times QF$$

$$rem = rad \times QF$$

ارزشهای QF که در تعریف بیشینه دوز مجاز به کار می‌رود	
نوع پرتو	فاکتور چونی (کیفیت) QF
پرتوهای رنتگن و گاما	1
پرتو بتا با انرژی بیشینه بزرگتر از 0.03 MeV	1.7
نوترونها و پروتونها تا انرژی 10 MeV	10
اگر چشم تابش شود	30
ذرات آلفا از مواد رادیواکتیو طبیعی	10
هسته‌های سنگین	20

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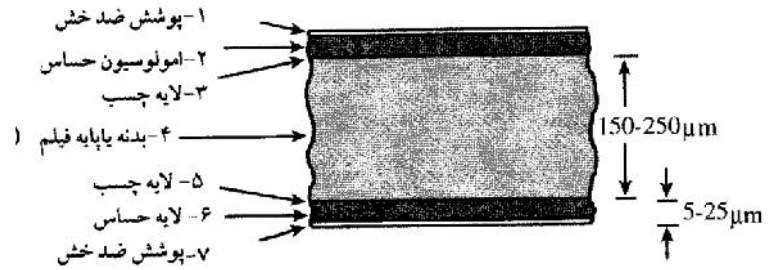

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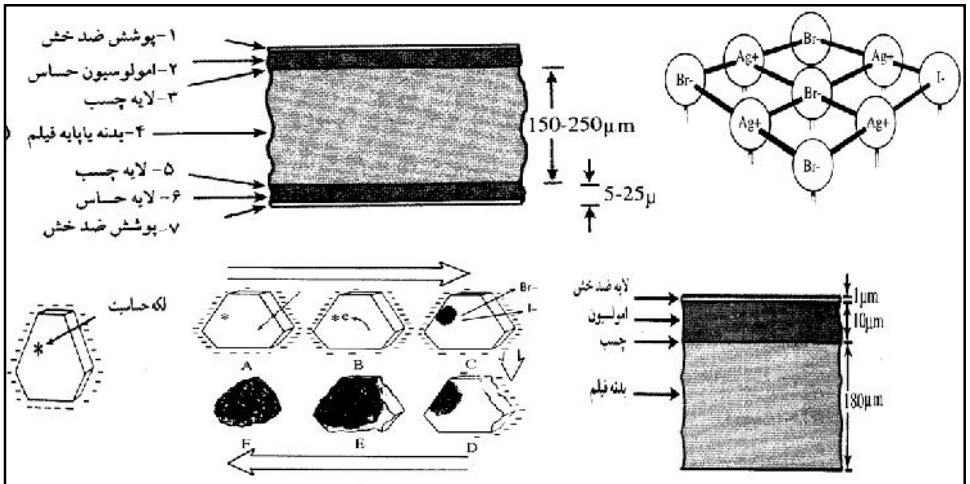

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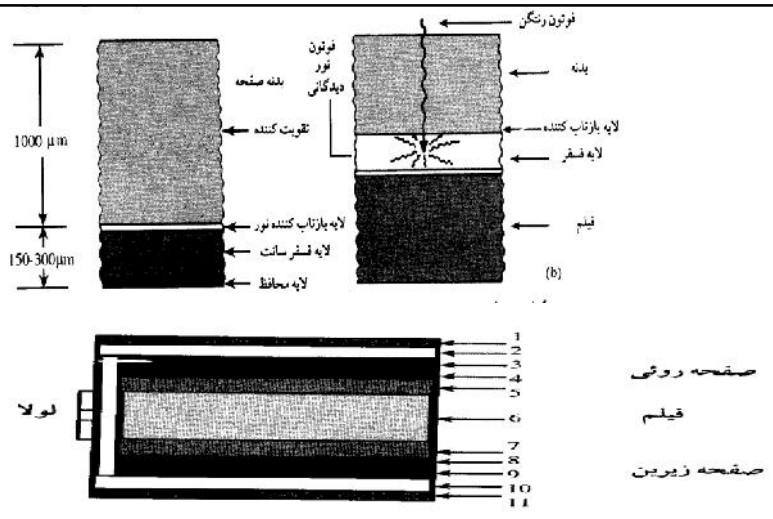

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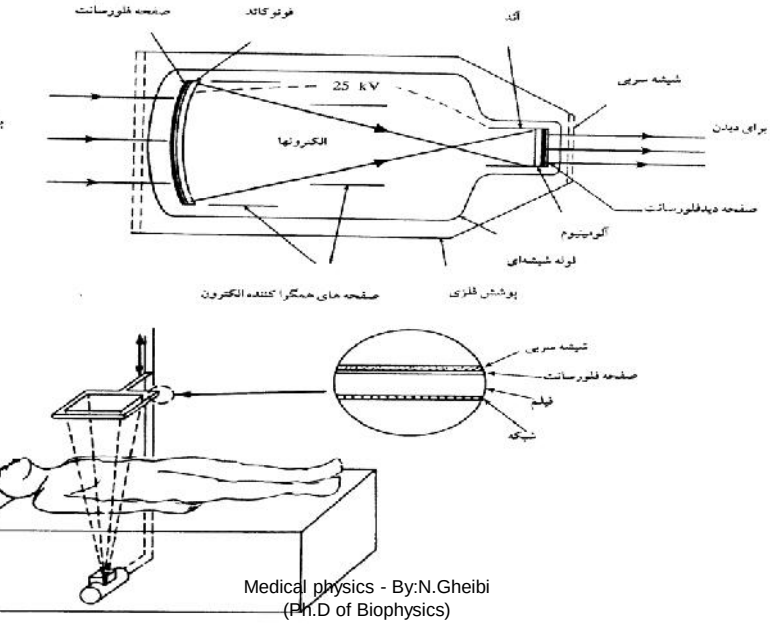

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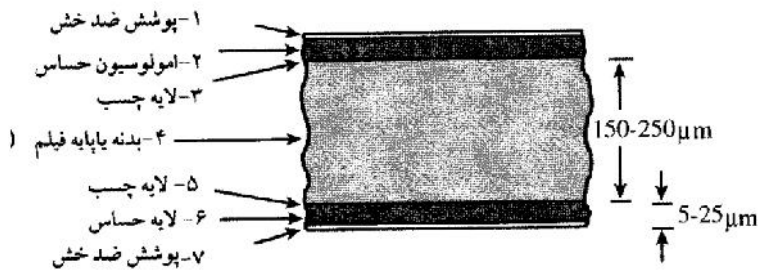

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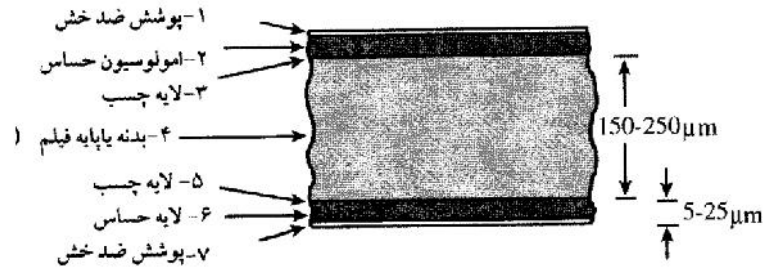

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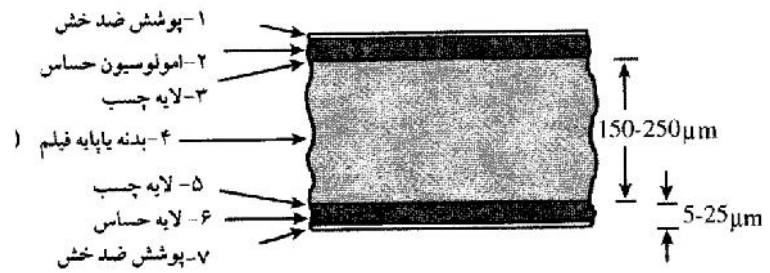

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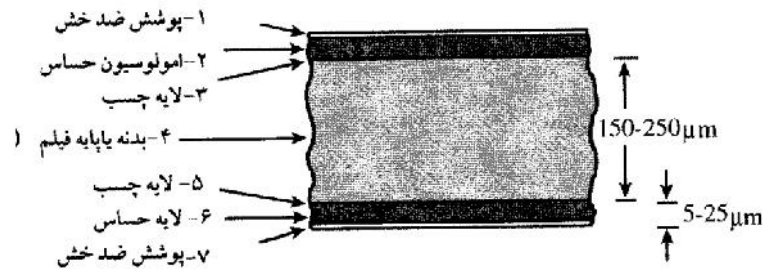

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